POWER and THE ENGINEER

EVERYTHING ABOUT THE GENERATION AND TRANSMISSION OF POWER

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TWO steam plants are separated by a narrow street and mill yard. The machinery in one is kept clean and polished. The engines run without pounding, the floor is partially covered with rubber matting, and shrubs and plants in neatly made boxes fill the sunny windows. The work bench on one side of the engine room is free from the litter of former repair jobs. The engineer goes about his duties with a contented mind, seemingly at peace with the world and everything in it.

The man in charge across the way is not an engineer, and his surroundings show it. The engine thumps twice with every revolution, and lesser noises from the dashpot intermingle. The fellow who keeps it going has a long tale of woe. He not only starts, stops and oils the engine, but runs a lathe, does repair work about the factory and makes himself anything but an engineer.

The engine room has the appearance of a pipe fitter's stock room, and dirt and dust lie thick upon the walls, floors and windows. This man is frequently absent from the engine room for an hour or more at a time. He trusts to luck that nothing will happen, and in the meantime envies the engineer across the way who seems to have a "snap."

If you were an employer which of these two men would you hire?

Surely not the Jack-of-all-trades.

Nobody points to him or his plant, except, perhaps, in derision. Nobody asks his advice on engineering subjects. He is a disgrace to the trade.

By all means avoid such a reputation. If your conditions are much the same, spend every moment you can on the engine. Get it so it will run as an engine should. Have the floor, walls and windows cleaned up. It is better than working in filth day after day.

The first thing you know, the manager will begin to take notice. Next he'll become interested, and if you can show him that by a closer application to the duties of the engine and boiler rooms, you can save him dollars and cents, it won't be very long before he will hire a man to do the chores around the place and get a higher estimate of your place and purpose.

Such a change will not take place in a day or week, and perhaps never in some plants.

But there are manufacturers all over the country who are learning a whole lot about the power end of their business. They are looking for engineers, clean, able men who can run a steam plant as it should be run.

And if you can "produce the goods," your opportunity will come sooner or later.

In the meantime, be on the job!

Setting Link Driven Valves

Relative Positions of Crank, Eccentrics, Link and Valve at Various Points of Stroke. Valve Opening at Centers and at Quarter Stroke

BY WARREN O. ROGERS

Directions for setting the ordinary slide valve can be found in almost any textbook, and the subject is more or less understood by the average engineer. But, setting the slide valve driven by the link motion is seemingly more difficult, although in reality it does not differ to any great extent from setting the same type of valve without the link motion.

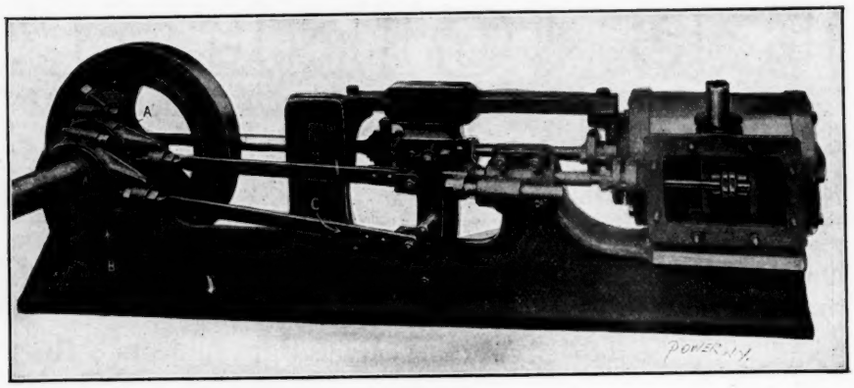


FIG. 1. SHOWING POSITION OF LINK AND LEAD, ENGINE RUNNING UNDER

If it were not necessary to reverse the direction of rotation, as with hoisting engines, dredges, elevators and the like, there would be no necessity for a link motion, and the eccentric and rod would be arranged as in the case of the ordinary slide-valve engine. In order to accomplish this reversing motion, without changing the position of the eccentric, the so-called Stephenson link motion has been adopted and is found in almost universal operation.

The link imparts motion to a slide valve by means of two eccentrics, each independent of the other and either controlling the action of the valve, either as a whole or in part, all depending on the position of the block in the link.

In Fig. 1 is shown an engine equipped with a link motion, the engine running under. It will be seen that the eccentric *A* is set with an angle of advance, of the amount necessary to produce the necessary valve lead with the crank on the outer dead center; that is, the eccentric is set with its greatest radius from the center of the shaft more than 90 degrees ahead of the crank. This is what would be required if the engine were of the ordinary slide-valve type, and if the engine were to be reversed it would be necessary to revolve the eccentric around on the shaft in the direction in which the engine is to run, until the eccentric is set with its greatest radius 90 degrees back of the crank, plus the angle of advance. The eccentric would then be at the position shown at *B*.

If two engines, each of the same size and design, were fitted with valve and eccentric, and having the same stroke, and the eccentric were set on one to run over, or the outward stroke away and over from the cylinder, and the other engine had its eccentric so set that the engine would run under, or the crank running under the shaft away from the cylinder when the piston is moving toward the crank end of the cylinder, the two would be similar to one engine fitted with two eccentrics and arranged so that either one would operate the valve independently of the other; the engine could be made to run in either direction by changing the valve motion from one eccentric to the other.

That is just what is done in the case of the link motion, and the process of setting the valve of the link-motion engine is practically the same as that of the ordinary slide-valve engine. All that must be borne in mind is that one is practically setting the valve of two engines, one to run over and the other to run under, the difference being, however, that the operation is to be performed on the one engine. If the link block is in either extreme position, down or up, Figs. 1 and 3, the eccentric governing the eccentric rod in line with the center of the link block is the one that is governing the valve.

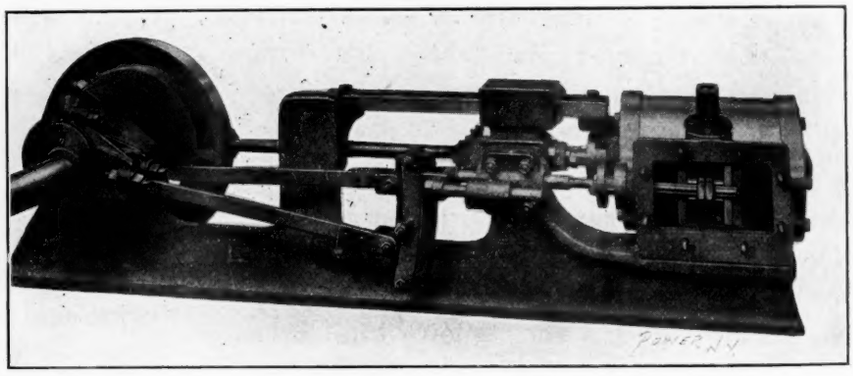


FIG. 2. ENGINE ON HEAD-END DEAD CENTER, SHOWING OPPOSITE LEAD

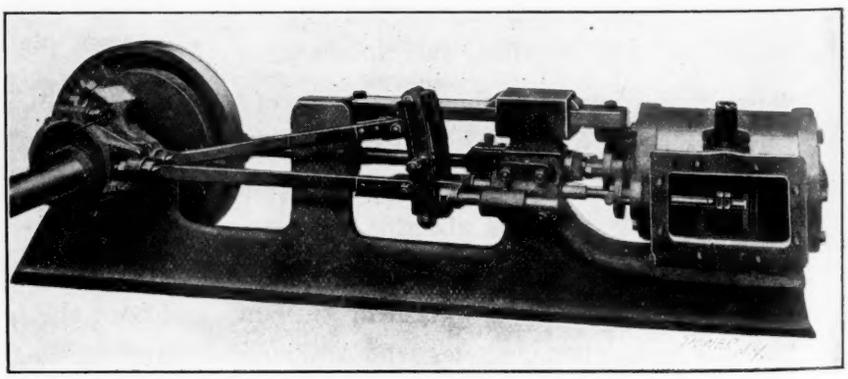


FIG. 3. POSITION OF LINK, ENGINE RUNNING OVER

If the link block were in the position shown in Fig. 1, the eccentric *A* would

govern the valve movement. If, on the other hand, the link block were in the position shown in Fig. 3, the eccentric *B* would govern the valve. It will be noticed that the valve in Fig. 1 is opening the port at the crank end and the engine will run under. In Fig. 3, however, the valve is opening the port at the head end of the cylinder and the engine will run over.

With the link block at either extreme position the valve will travel the full throw of the eccentric, but if the link block is placed in any position between its extreme position and mid-travel the one eccentric effects the control of the other eccentric and the valve has less travel, consequently the point of cutoff is changed. This is known as hooking up an engine and the change can be quickly noticed on locomotives.

Before a valve can be set correctly the engine must be placed with the crank on the dead center. Some misguided engineers have, at times, attempted to place an engine on the dead center by judging as best they could the point at which the crosshead stops its travel, or by stopping the engine when it appears that the crank is on the dead center, when compared with the connecting rod, but accurate valve setting cannot be obtained by such a procedure. Another method is to use a spirit level, but this method is not advisable, for if the engine is out of level, and many of them are, the level will register falsely as to the point when the crank is at the dead center.

The method usually employed is that of tramming where the engine is equipped with a flywheel, and is accomplished as follows: First, the engine is turned so that the crank stands at some slight angle above the dead center or at a position so that the crosshead will have a movement if the crank were turned toward the center. Then a scratch is made across the crosshead and the guide with a scratch awl or some other instrument that will make a slight, fine mark. A center-punch mark is also made on the rim of the flywheel at some convenient distance from the floor. The crank is then turned past the center until the marks on the crosshead and the guide are again in line, when another center-punch mark is made on the rim of the flywheel, at the same distance from the floor as in the first instance. A center-punch mark is then made midway between the two marks on the rim and then the flywheel moved until the middle mark is the same distance from the floor that the original marks were, a tram being used to gage the distance. If the measurements have been made correctly, the engine will then be on the exact dead center.

If the engine has no flywheel the marking can be done on the rim of the crank disk, but more care must be exercised, as the measurements will necessarily be more exacting, because the diameters of the flywheel and crank disk are so different that the one has a much greater movement of the rim than the other with the same crank movement. Another method is to secure a straight-edge on the crosshead guide and set a pair of hermaphrodite calipers with one leg in the center of the shaft and the other against the bottom of the straight-edge. Then turn the crank pin until the calipers will give the same measurement from the center of the crank pin to the bottom of the straight-edge.

When setting the valves of an engine of the slide-valve type it is, of course, necessary to place the valve on the valve stem in the proper position and then set the eccentric so that the valve will have the proper amount of lead, about 1/32 inch. If a link motion is used the valve should have the same amount of lead and perform the same functions at both the forward and backward motions, and when the link is hooked up. Supposing that the engine to be got into running order has been dismantled and the eccentrics are loose on the shaft. Naturally the heaviest side will be down and both eccentrics are far from occupying the positions they should were the valve and link gear properly set. Therefore, the thing to do is to turn the eccentrics to a position nearly to that which they will occupy when the valve is properly set. For the go-ahead eccentric this will be at an angle of 90 degrees with the crank pin, plus the angle of advance, as at *B*, Fig. 3, and the other eccentric will occupy a position opposite to the position of ec-

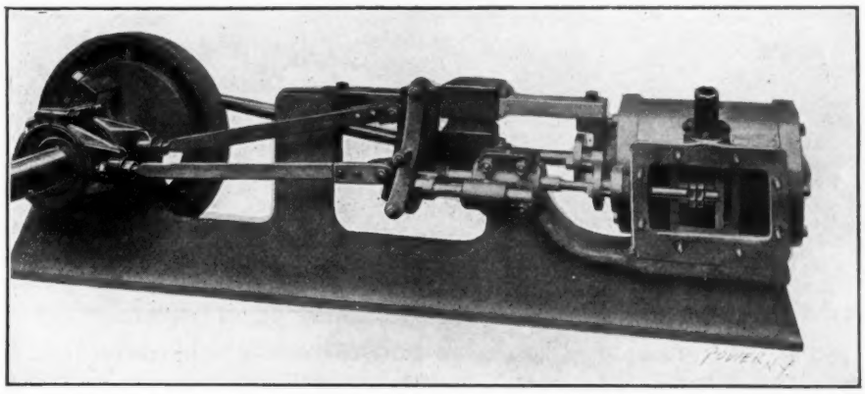


FIG. 6. CRANK ON THE QUARTER, ENGINE RUNNING OVER

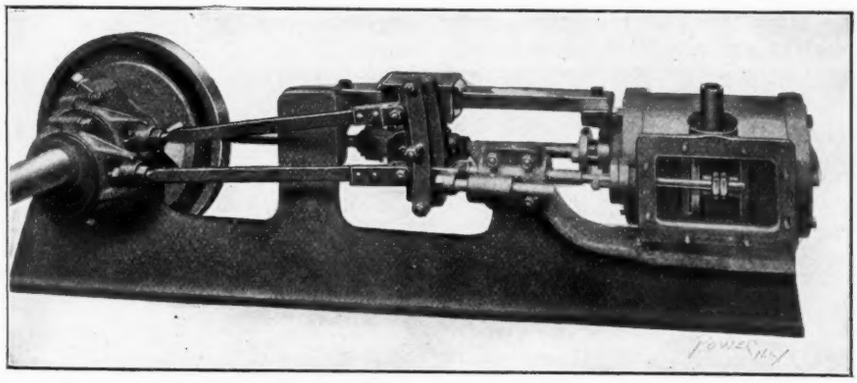


FIG. 4. POSITION OF LINK, ENGINE RUNNING OVER

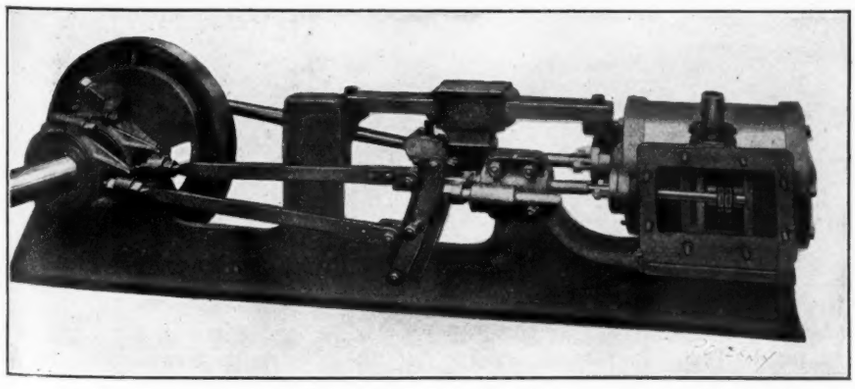


FIG. 5. CRANK ON THE QUARTER, ENGINE RUNNING UNDER

centric *B*, or 90 degrees behind the crank pin, plus the angle of advance, as at *A*, Fig. 1.

Before beginning to set the valve it is necessary to so adjust the reversing-lever link that the link block will stand at mid-position when the lever is at the middle notch of the quadrant. When this adjustment has been made the reversing lever is placed in the go-ahead position and the crank set on the head-end dead center, as already described. The link would then take the position shown in Fig. 3. A measurement of the valve opening, or lead, is then made, preferably with a small scale. Many advocate the use of a wedge-shaped piece of wood and note the distance it goes in the port opening, but if care is not exercised in measuring the other side of the valve when in its opposite position, the stick is liable to be placed in the port on a slant, which is apt to give a false reading.

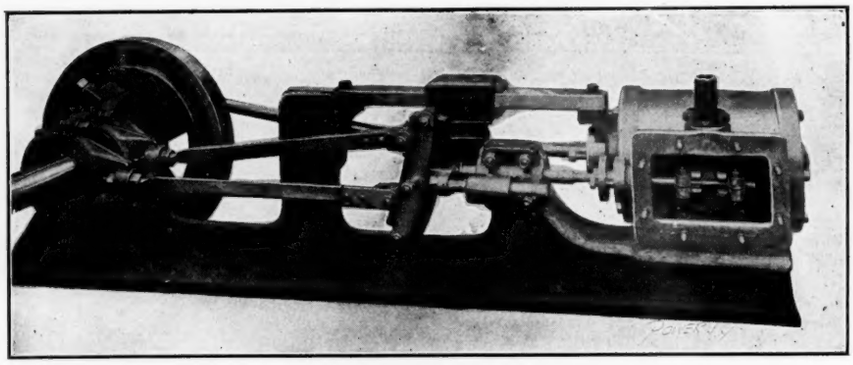


FIG. 7. LINK MID-POSITION, CRANK ON TOP QUARTER AND BOTH STEAM PORTS CLOSED

The first thing after getting the valve and eccentrics set approximately is to test for lead on both sides of the valve, both in the forward and backward motion. Assuming that the reversing motion is in the forward position, and that the valve is found to have 5/16-inch lead on the back center and ¼-inch negative lead, or lacking ¼ inch of being open with the crank on the crank-end dead center, the position of the eccentric would, therefore, give a total lead of the difference between 5/16-inch lead and ¼-inch negative lead, or 1/16 inch. To adjust, give the valve edges one-half the total lead, which can be done by lengthening the lower eccentric rod *C*, Fig. 1, one-half the total lead, or 1/32 inch plus ¼ inch, the negative lead.

Taking up the backward motion and assuming that the valve had ⅜-inch lead back center, or with the engine on the head-end dead center, the difference will be ⅜ — ⅛ inch, or ¼ inch. Proceeding as before we find that one-half of ¼ is ⅛ inch. This difference added to the negative lead ⅛ inch makes a total of ¼ inch, which is the amount the eccentric rod *D*, Fig. 3, must be lengthened to produce an equal valve opening at each end. After the valve has been so set that it gives the same lead at each end, the eccentric for each forward and backward motion should be adjusted to a position so that the valve lead will be 1/32 inch.

In case it is not understood how the eccentric rods may be adjusted for length it is only necessary to state that this may be done by adding or taking away liners placed between the eccentric rod and eccentric strap, in some types, while screwing in or out of the rod in the eccentric will be found to be the method in others, as shown in the illustrations.

In getting the final adjustment of the eccentrics and valve lead it will be necessary to place the engine on the dead center and place the reversing lever in the backward motion, after which turn the eccentric toward the crank until the valve has 1/32-inch lead, Figs. 1, 2, 3 and 4.

In hoisting engines it is usual for the link motion to be so connected that the lead is increased as the link block is moved toward the center of the link. This calls for the connecting of the eccentric rods crossed, as when the link block is placed in the center of the link the engine will stop. With eccentric rods connected as shown in the illustrations, the engine will not stop with the link block in the center of the link if the engine has two cylinders, with cranks set at 90 degrees with the other.

In order that a comprehensive idea of the relative positions of the valve, crank, eccentrics and link may be obtained at a glance the various illustrations are presented. The original photographs were taken from one side of a Lidgerwood double-cylinder hoisting engine, but to avoid confusion all parts but those under discussion have been removed, and the method of adjusting the valve on the valve stem changed somewhat, in order that the port opening may be seen to better advantage, Fig. 7, showing the true methods of adjusting the valve.

Fig. 1 shows the crank on the crank-end dead center, the link being in its lowest position. The engine will run under because as the crank moves toward the top quarter the port on the crank end of the cylinder is opened. Should the crank be on the under side of the dead center and turned in the opposite direction, the lead would decrease and close the port on that end of the cylinder. The valve is controlled by the inside eccentric.

In Fig. 2 is shown the position of the valve, crank and eccentric, with the engine on the head-end dead center, the link motion still being in its lowest position. It will be noted that the valve lead is at the opposite end of the cylinder from that shown in Fig. 1, and the engine is ready to begin its return stroke, the valve being controlled by the inner eccentric.

Fig. 3 shows the engine in the same position as shown in Fig. 2, with the exception that the link is in its highest position, and the valve is controlled by the outside eccentric. But as the outside eccentric is set different from the inside eccentric, the engine will run over, because the eccentric leads the crank. Although the port opening is the same as in Figs. 2 and 3 and at the same end of the cylinder, the engine will run in an opposite direction, because the two eccentrics are set at different angles with the crank. By noting the relative position of the eccentric to the crank and keeping in mind the direction of rotation and the position of the link, the matter becomes clear.

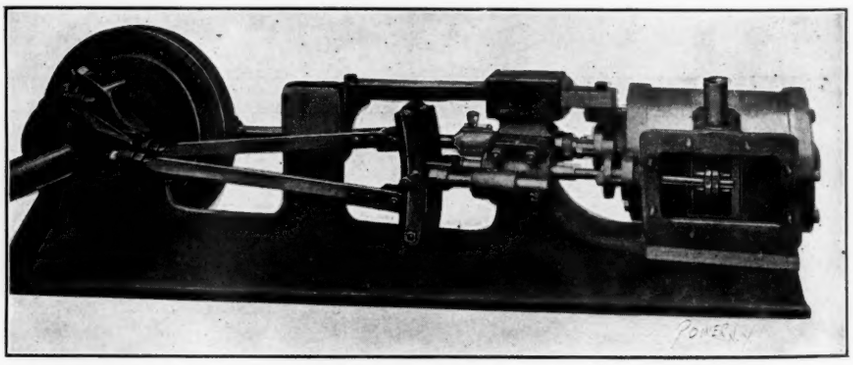


FIG. 8. LINK BLOCK IN MID-POSITION, VALVE HAVING 1/32-INCH LEAD

Fig. 4 shows the engine in the same

position as in Fig. 1, with the exception that the link is in its high position. The engine in this case will run over, the outside eccentric controlling the valve movement.

Although moving the link from its highest to lowest position with the crank on the dead center does not move the valve, as shown in Figs. 2, 3 and 4, the port opening being the same in both instances, it does make a difference when the crank is in any part of the circle described in making one revolution other than the opposite dead center. This is shown in Figs. 5 and 6, while the engine is shown on the top quarter in both instances. In Fig. 5 the link has been dropped to its lowest position, and the port on the crank end of the cylinder is nearly open, the engine running under. In Fig. 6 the link is in its highest position and the port opening is found to be on the head end of the cylinder, although the crank is on the top quarter, as in Fig. 5, the engine running over.

If the link were dropped to mid-position, as shown in Fig. 7, with the crank on the top or bottom quarter, the valve would be in mid-position and both steam ports would be closed. If the engine had but one cylinder, it would not start.

In Fig. 8 the engine is shown on the head-end dead center, with the link in mid-position. The port is open at the head end, and if the crank were on the outer dead center, the opposite port or crank-end port would be open the amount of the valve lead. Comparing Figs. 7 and 8 it will be seen that as the crank leaves at dead center the valve is closed as shown in Fig. 7. Therefore, the engine would stop, unless in the case of exceedingly light or friction loads, when the engine might receive enough steam in the cylinder to keep it revolving at a slow rate of speed. If the eccentric were connected differently, that is, if the cross method of connection were used, in which case the top eccentric connection from the link is connected to the outside eccentric, and the bottom link eccentric rod connected to the inside eccentric, the engine would not start without changing the position of the link. This is undoubtedly the safest method of connection, and yet is seldom found on small types of engine.

The Föttinger Hydraulic Gear

Reduction and Reversing Gear for Turbines with an Efficiency Ranging between 75 and 85 Per Cent. Gas and Oil Engines also Offer Inviting Field for the Gear

BY DR. ALFRED GRADENWITZ

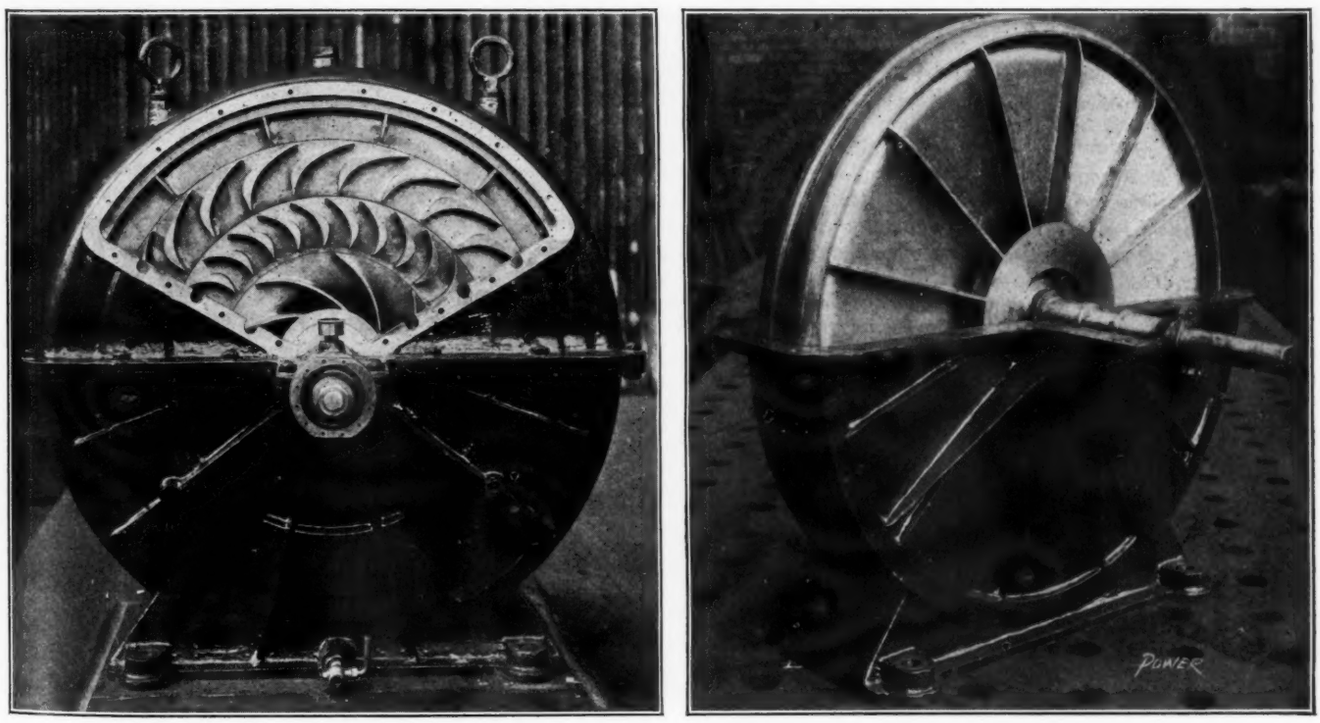
The two most serious difficulties met with in adapting the steam turbine for the purpose of ship propulsion are the impossibility of simple reversing and the necessity of maintaining speeds of revolution five to fifteen times higher than the number of turns of the best propellers. The best solution so far suggested for this problem, outside of the reducing gears recently developed, are the Parsons series coupling of various turbines mounted on different shafts, and the self-contained single-shaft turbine developed by Curtis and the Allgemeine Elektricitats Gesellschaft.

In spite of the excellent results obtained by these ingenious schemes, the hopes entertained at the beginning have only been partially realized owing to the undoubted drawbacks inherent in an immediate coupling between the turbine and propeller, and the resulting necessity of choosing a compromised speed.

Prof. H. Föttinger, chief engineer at the Vulcan shipyards, has found a solution of this problem, which allows steam turbines to be used for ship propulsion under more economical conditions than have heretofore been possible.

According to his scheme, a slowly running, highly economical propeller is operated by a high-speed turbine working under the most economical conditions, through a gearing of an efficiency of about 75 to 85 per cent.

After discarding both toothed-wheel



THE TURBINE TRANSFORMER

and electrical transmission, Föttinger found a most efficient means of power transmission in an improved hydrodynamical gear.

According to the most primitive arrangement such a scheme would comprise (Fig. 1) a prime mover, transmitting its energy to a turbine wheel *A*, mounted on the primary shaft, e.g., the wheel of a centrifugal pump, which draws in and compresses the working liquid

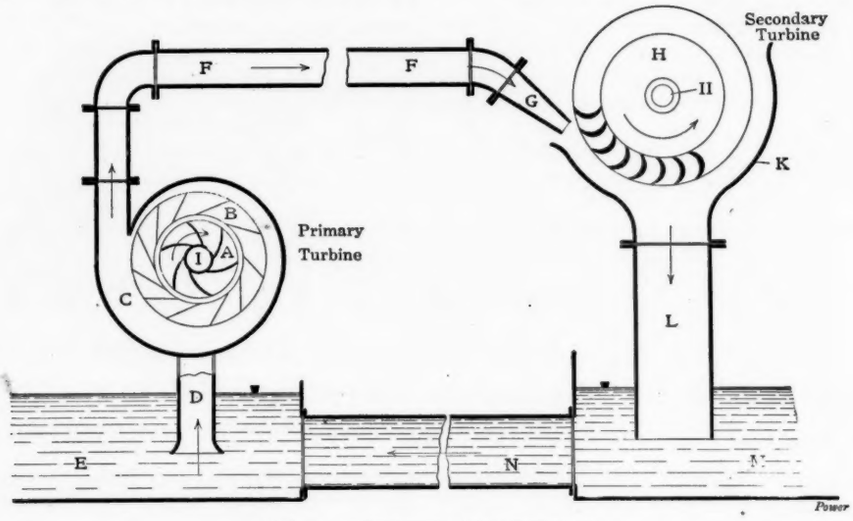


FIG. 1. PRIMITIVE ARRANGEMENT

derived from a reservoir. The high issuing speed of the working liquid is slackened down and partly converted likewise into useful pressure behind the primary or pump wheel, in what is called an effusor, viz., some kind of guiding wheel *B*. From this effusor the liquid enters a spiral casing *C*, collecting the different jets and yielding them to the conduit *F*, which communicates with a secondary turbine. In Fig. 1 this is represented as a Pelton wheel, consisting of a guide *G*, reconverting the high pressure of the liquid into speed, the turbine wheel proper *H*, which is mounted on the secondary shaft, and a discharge casing *K*, which supplies the exhaust water to an exhaust conduit, connected with some reservoir, river or the like. The working medium can be returned to the suction reservoir or the pump in order there to be further utilized.

Now, though the efficiency of this primitive arrangement is obviously extremely low—less than 70 per cent.—a similar scheme has been recently suggested for the propulsion of ships and automobiles. The space and weight requirements are, however, objectionable.

Quite different conditions are met with in connection with the new hydrodynamical transmission gear developed by Professor Föttinger, which forms the essential part of his invention.

As represented in Fig. 2, this gear comprises a turbine wheel *A*, mounted on the primary shaft, which transmits the energy it receives to the entering working liquid, e.g., water, partly by acceleration and partly by an increase in hydraulic pressure.

Whereas, in the primitive arrangement shown in Fig. 1, the issuing jets as far as their entrance into the turbine undergo a double conversion of energy, viz., first from speed into pressure in the pump effusor and then from pressure into speed in the turbine guide, this double conversion is done away with in the present case, the issuing jets being conducted immediately onto a turbine wheel operating the secondary shaft, and which surrounds concentrically the pump. In the secondary wheel *B*, Fig. 2, the water is deprived of most of its energy. The issuing jets penetrating into the stationary guiding wheel *C* are there arranged conveniently in order to be thrown back immediately into the pump with a loss of energy as small as possible, after which the same alternation of energy conversion, acceleration in the pump wheel and performance of work in the secondary wheel, is repeated over again. The water thus only flows through the turbine wheels immediately serving for the transmission of energy, which wheels are so designed and combined with one another as to constitute an entirely closed cycle formed by the side walls of the various wheels, from the primary wheel to the secondary wheel and back again. This cycle takes the shape of a hollow vortex comparable to a smoke ring. The usual form of the water-turbine wheel has been abandoned entirely and been replaced by a thorough rearrangement adapted to the purpose at issue. Fig. 3 shows schematically the wheel paddles "unwound," as used in the present case.

According to the slightly modified scheme represented in Fig. 2, the working water, before penetrating into the secondary wheel *C*, undergoes a convenient alteration in speed, mainly according to its direction in the guide *B*. From the secondary wheel *C*, the water returns immediately or through a short guide into the pump, in order there to be endowed with new amounts of energy. This arrangement is especially adapted in case the secondary shaft is to be reversed against the primary one.

Many further variations and combinations of the schemes are possible, and the number of secondary and guiding wheels (in a similar manner to multiple-stage turbines) can be increased in accordance with the ratio of transmission.

Fig. 4 thus shows in its left-hand half, an arrangement with double-stage secondary part, in connection with which the working water from the pump *A* penetrates into the first secondary wheel *B*, thence into a stationary guide and finally into the second secondary wheel *D*, in order thence to return to the turbine. The higher the ratio of transmission, the greater will have to be the number of secondary wheels. The same arrangement can be reversed by designing the pump with several stages, with a view to conversion to higher speeds.

At the recent meeting of the German Society of Nautical Engineers, Professor Föttinger demonstrated this very important double-stage arrangement on a working model actuated by an electromotor. The capacity of this model was about seven horsepower, the transmission ratio being 5 to 1; the primary speed 400 revolutions per minute and the secondary speed 80 revolutions per minute. The secondary speed could be adjusted to any figure intermediary between no load and stopping by a self-regulating brake.

The arrangement above described obviously affords the advantage of dispensing with any suction tube, bending tube, spiral housing and discharge housing in the pump and turbine, thus re-

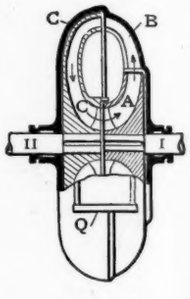


FIG. 2

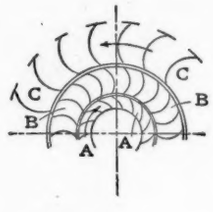


FIG. 3

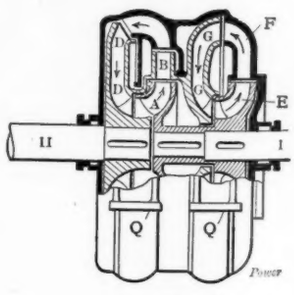


FIG. 4

ducing the weight and space requirements to a minimum. At the same time any friction and vortex losses resulting from the arrangement of these accessories are obviously done away with. Again, the double energy transmission above referred to is avoided entirely, thus reducing the heavy losses thereby entailed. Another good point is that any discharge loss, as obtaining in an ordinary centrifugal pump and head turbine on account of the nonutilized issuing speed of the water is avoided in the present case.

Now, the most important question arising in connection with the new arrangement obviously relates to the efficiency to be attained. Theoretical considerations show this efficiency to be 80 to 82 per cent., in the case of large units, with a four- to five-fold transmission, and these results have been borne out by actual practice. In order to allow these facts to be adequately gaged, Professor Föttinger discussed the efficiency obtainable in the case of some low-pressure turbines of the best makes and some modern water turbines constructed by the greatest German turbine factories. In the former case were found efficiencies of 85 to 86 per cent., and in the latter case of 84 to 85 per cent., even with small units. While these figures apply to pumps and turbines in connection with which part of the water energy is allowed to go to waste, the use of the Föttinger turbine transformer would insure at least an additional 3 per cent.

The efficiency of the hydrodynamical transformer obviously depends on the ratio of transmission. In the case of a four- to six-fold transmission, 80 to 82 per cent. can be readily obtained with two secondary stages, while an eight-fold transmission can be effected with three stages and an efficiency of about 80 per cent.

be recovered nearly entirely, being transmitted, e.g., to the feed water, which is then preheated permanently from 20 to 25 degrees Centigrade without the use of any coal. This arrangement allows any heat-transmission surfaces to be dispensed with, by causing the feed water merely to circulate through a hydrodynamical transformer. The temperature then is maintained automatically at practically constant figures with different loads, as in the case of smaller amounts of condensed water there are produced smaller heat losses; this arrangement increases the efficiency of an 80 per cent. transformer to 83 per cent.

The very important problem of steering, and especially reversing, can be solved in three different ways, the steam turbine, controlled by a regulator, continuing in each case to run in a constant direction.

The first method consists of designing a special self-contained cycle for each course. In the case of forward traveling there is filled one cycle, and in the case of backward traveling, the other one, the cycle actually inactive being discharged in each case into a small tank. This is effected by means of the substantial centrifugal pumps of the cycles themselves in conjunction, if desired, with a special small auxiliary centrifugal pump, which at the same time serves to make up for the leakage water escaping from the stuffing boxes, etc. This arrangement is what is called "type 1."

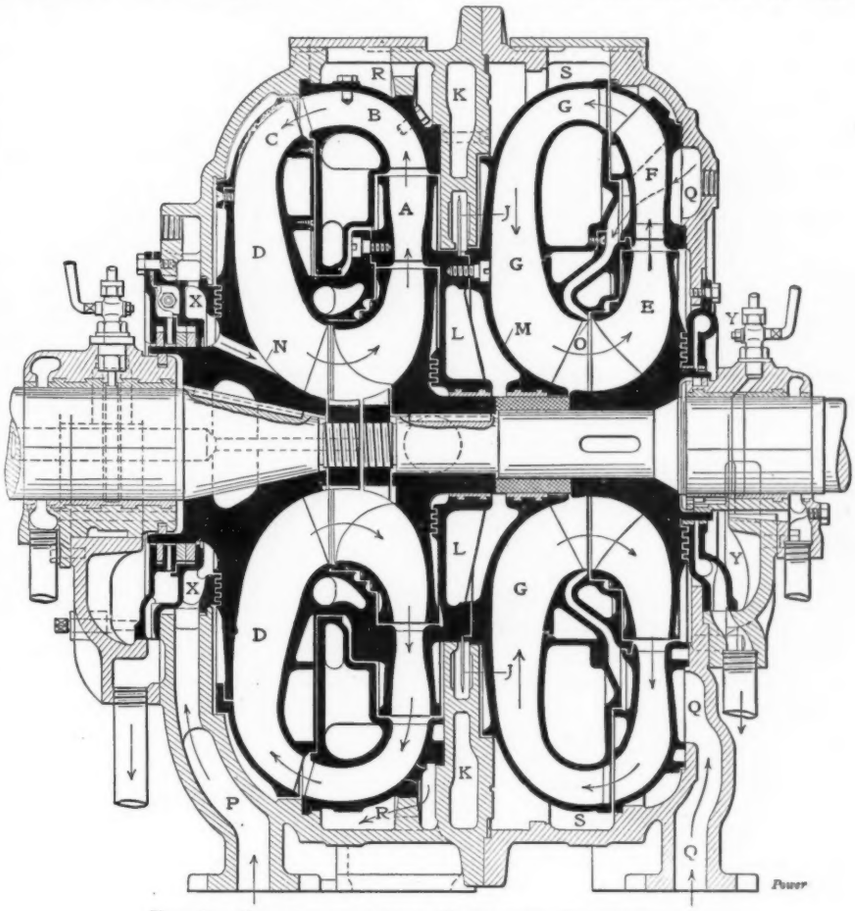


FIG. 8. SECTION THROUGH HYDRAULIC TRANSFORMER

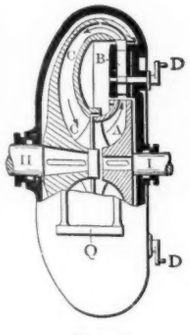


FIG. 5

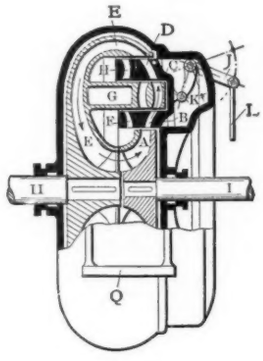


FIG. 6

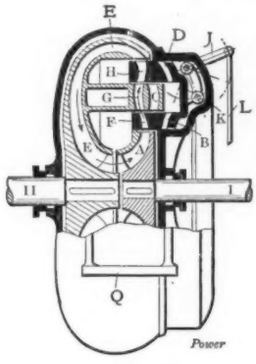


FIG. 7

Another method consists of using part of the turbine wheels, e.g., the pump and a secondary wheel, both for forward and backward traveling, and effecting the reversal by altering or exchanging the guiding devices. The shape of the paddles in certain types of secondary wheel in fact lends itself immediately for both forward and backward traveling. The reversal is effected by means of rotary flexible or tilting guiding vanes, reversed by hand or by a reversing machine. Fig. 5 represents a single-stage arrangement of this kind with rotary vanes *B* reversed simultaneously by the outside cranks *D*.

Of special importance is a solution

represented in Figs. 6 and 7, where the reversal is effected by means of movable guiding devices, which constitute annular piston slides adjusted in an axial direction by a reversing machine or by the water pressure in the transformer.

This arrangement allows one of the turbine wheels to be thrown out of the cycle while throwing in another one, which is of special importance in connection with secondary wheels with inside charge, as these can be used only for one direction of rotation. This arrangement is called "type 2."

A third possibility, which especially applies to the case of a very rapid reversal, in conjunction with type 1 and especially with type 2, consists of leaving the cycle in question filled while rendering it inactive by some kind of slide (rotary paddle or the like).

The question of regulation, that is, adjusting to different outputs and speeds, is closely connected with the steering problem. In the case of a constant transmission, the output absorbed varies with a given transformer at the same ratio as the third power of the number of turns. Now, as this law is true with a very close approximation also in the case of the ship propeller, the transmission in the case of ship propulsion remains constant even without any special regulation device, and the same applies within very wide limits to the efficiency of the arrangement. The primary output desired is adjusted in the steam turbine by opening and closing admission nozzles, or, in the case of rapid steering, merely by means of the steering valve. This method is by far the most simple, and leaves the transformer entirely unaffected. A decrease in the output thus reduces the number of turns of the steam turbine at about the same ratio as that of the propeller shaft while this entails a smaller decrease in efficiency than in the case of brake operation.

On account, however, of the numerous stationary applications of the new turbine arrangement, the inventor has considered also the question of regulation in the transformer itself, i.e., especially a variation in the ratio of transmission, and accordingly in the secondary number of turns with constant primary speeds of revolution. This problem could obviously be solved by the same devices as used for steering, i.e., by means of rotary vanes, movable guides, slot or grate slides and the like.

The task mainly consisted of effectually controlling the head and the amount of circulating water. The system used in this connection therefore is mainly identical with those designed for reversal (Figs. 5 to 7). Owing, however, to the closed cycle, those regulators can be inserted at any point of the cycle, according to hydraulic or constructive conditions. Whenever the possibility of reversing has likewise to be provided for, the slides should be fitted with three or more sets of channels.

Another regulating process consists of altering the number of stages. In addition to these various steering and regulating devices the inventor has patented a number of other possibilities.

The first experimental model constructed by the Vulcan shipyards is designed for transmitting the power of a 100-horsepower motor running 1000 revolutions per minute to a shaft rotating at a speed of 225 revolutions per minute, which corresponds to a ratio of about 4.5 to 1.

Type 1, in accordance with Fig. 4, was at first chosen. The double-stage forward cycle (Fig. 8, left-hand half) comprises the pump, the first secondary running wheel *A*, the guide *B* and the second secondary wheel *D*. The backward cycle, however, has been designed according to the single-stage type with the pump *E*, the reversing guiding wheel *F* and the secondary wheel *G*, in order to ascertain any difference in the efficiency of the two types.

The backward wheel *G* is screwed to the forward wheel *A*, and the latter to the second forward wheel *D*, which is mounted loose on the secondary shaft. The forward and backward cycles are separated by a wall, the annular compartments *J* and *K* of which catch the water streaming from the active to the inactive cycle (about 1.5 per cent. according to actual tests) in order to lead it to a vessel, whence it is conveyed back into the transformer by a small steering pump through the steering slide.

Admission into the forward cycle is effected underneath through *PXN*, and into the backward cycle through *Q Q* and some apertures in the guiding wheel *F*, toward *O*. On the same path is effected the filling during steering, whereas the discharge is effected through the annular compartments *R* and *S*, likewise across the steering slide toward the auxiliary vessel mentioned.

This method was submitted at the workshops of the Vulcan shipyards to comprehensive tests continued during several months under the most varied working conditions. Fig. 9 represents the experimental arrangement (consisting of a shunt motor and torsional indicator for measuring the primary output, the transformer and the brake for determining the secondary output).

The results of these tests bear out all the points provided by theory. The primary output was found in the case of different primary speeds of rotation, with constant ratios of transmission, to vary approximately as the third power of the primary number of turns. If, however, the primary number of turns be kept constant, the secondary speed being varied by means of the brake, the absorption of energy of the model will remain independent within wide limits of the secondary number of turns. The secondary torque, with a constant primary speed, was found practically to follow a rectilinear curve in a similar manner to ordinary head turbines. The torque, in case of stoppage, was found to increase considerably (in the same manner as with a reciprocating engine), which results in the advantage of an instantaneous starting and a very rapid running up to speed. The maximum efficiency within wide limits of primary speeds was found to correspond to a ratio of 4.25 to 1, whereas the calculated value was 4.45 to 1. In the case of a primary speed of 1100 revolutions per minute the

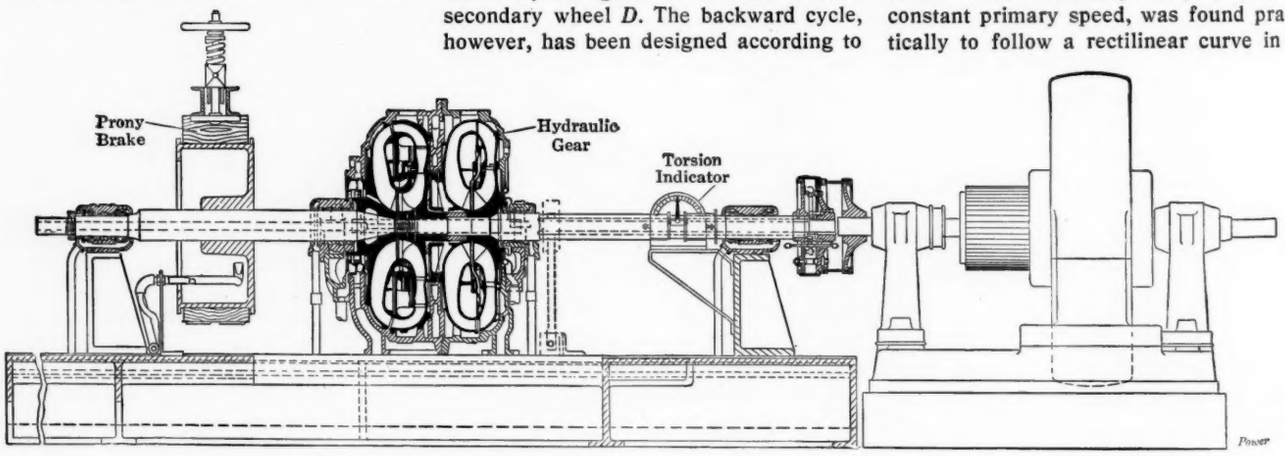


FIG. 9. EXPERIMENTAL ARRANGEMENT USED AT VULCAN SHIPYARDS

maximum efficiency of 83 per cent. was found to correspond to a secondary speed of 260 revolutions per minute in accordance with the above ratio of transmission. The turbine transformer was thus found to behave quite similarly to a head turbine, working under a constant head with constant guide-wheel aperture and variable numbers of turns.

As regards the variation in efficiency with variable primary speeds, i.e., variable primary outputs, a figure of 75 per cent. was obtained with 9½ horsepower; with 40 horsepower, 80 per cent.; with 100 horsepower, 82½ per cent., and finally, with 180 horsepower, 83 per cent. There seems to be a tendency for a further slow increase.

Tests made on the backward cycle further showed a maximum efficiency of 70 per cent., so that even with a single-stage cycle, a backward efficiency of about $70 \div 83 = 85$ per cent. of the primary efficiency with constant primary outputs, i.e., constant outputs of the steam turbine and boiler are reached.

On account of these excellent results obtained with the very first experimental model, the manager of the Vulcan shipyards decided on immediately equipping with this model a small experimental vessel built especially for the purpose, in order to be in a position to demonstrate in actual operation the principle underlying the new drive.

As no efficient steam turbine can be designed for an output of only 100 horsepower with 1000 revolutions per minute, they made up their minds to increase the number of turns to about 1750, thus raising the output from 100 to 500 horsepower. Because of the small first cost, a pure Curtis turbine was chosen as driving motor.

Being so small a plant, it was obviously not suitable for demonstrating its economical advantages; but the builders made a point of using the experimental vessel also for practical purposes, as transporting vessel, hauling vessel, ice breaker and ferry boat for the conveying of persons, visiting the Hamburg shipyards of the Vulcan company.

On account of these numerous requirements, the maximum speed was reduced to 12 to 13 knots. The main dimensions of this experimental launch are as follows: Maximum length, 96 feet 4 inches; width between frames, 14 feet 3 inches; displacement in river water, 2710 cubic feet.

The steam is generated in a narrow-tube, water-tube boiler of 31 square feet grate surface and 1615 square feet heating surface, at a pressure of 250 pounds absolute. Fig. 10 is a cross-section through the 500-horsepower turbine plant.

The steam turbine combined with the turbine transformer comprises four 3-rim Curtis wheels, the last of which is arranged on some kind of drum, generating an axial thrust opposite to that of the primary wheels *E* and *A*. The shaft of the steam turbine is located in two bearings and carries at the back the two loosely mounted primary wheels. At the front end of the turbine shaft is arranged a thrust disk, which readily deals with the whole of the steam thrust of the turbine. A regulator with throttling valve prevents, in the same manner as in connection with stationary turbines, the speed of rotation from exceeding a given figure (in the present case about 1900 revolutions per minute), in addition to which there is provided an emergency regulator in case of failure of the main regulator. Owing to the relatively considerable diameter of the propellers, the shaft had to be given a comparatively considerable inclination, for which reason the ratio of transmission was raised to 5.6 to 1.

In the engine room are arranged, in addition to the main turbine of 500 horsepower and the surface condenser, two duplex pumps, a circulation pump with dry-air pump, an oil pump and a hot-water tank.

This plant, in all its parts, has given excellent results in practical operation. Steering is effected in a surprisingly rapid and reliable manner. If, in case of a forced course, the steering lever of the slide be turned over from "forward" to "backward," while the steam turbine continues operating in the same direction, the secondary shaft can be stopped within 4 to 5 seconds, and will reach a backward speed of 200 to 250 revolutions per minute after a further 10 seconds.

An interesting feature is that the Parsons' series connection can be combined to much advantage with a Föttinger transformer. Furthermore, the use of the transformer can be, if desired, limited to the cruising turbines, the main turbines being allowed to act directly on the shaft, whereas one or two small high-speed cruising turbine wheels are coupled to the shaft through a transformer. By substituting a single set of this kind, capable of being thrown out, for the large reaction, cruising turbines generally used, a remarkable saving in space and weight, and in many cases an increase in cruising efficiency could be obtained, while doing away with any difficulties relating to the thrust bearings. The new drive is likely to prove of importance also in connection with combined reciprocating engine and turbine drives, transmitting either the output of exhaust-steam turbines to the two reciprocating-engine shafts, or reducing to reasonable limits the dimensions of the exhaust-steam turbine working on a third shaft. Furthermore, the gas turbine, should it ever overcome the enormous difficulties inherent in its construction, is likely to use to much advantage the Föttinger transformer. This, in addition, may be said also in connection with any oil- or gas-combustion motors, the regulation and steering of which open up a wide field of application to this ingenious device.

Apart from its nautical applications, the Föttinger transformer will be found of service also for the operation of all kinds of stationary plant, e.g., rolling-mill engines; in fact, whenever a powerful high-speed motor is used for operating a slowly running machine.

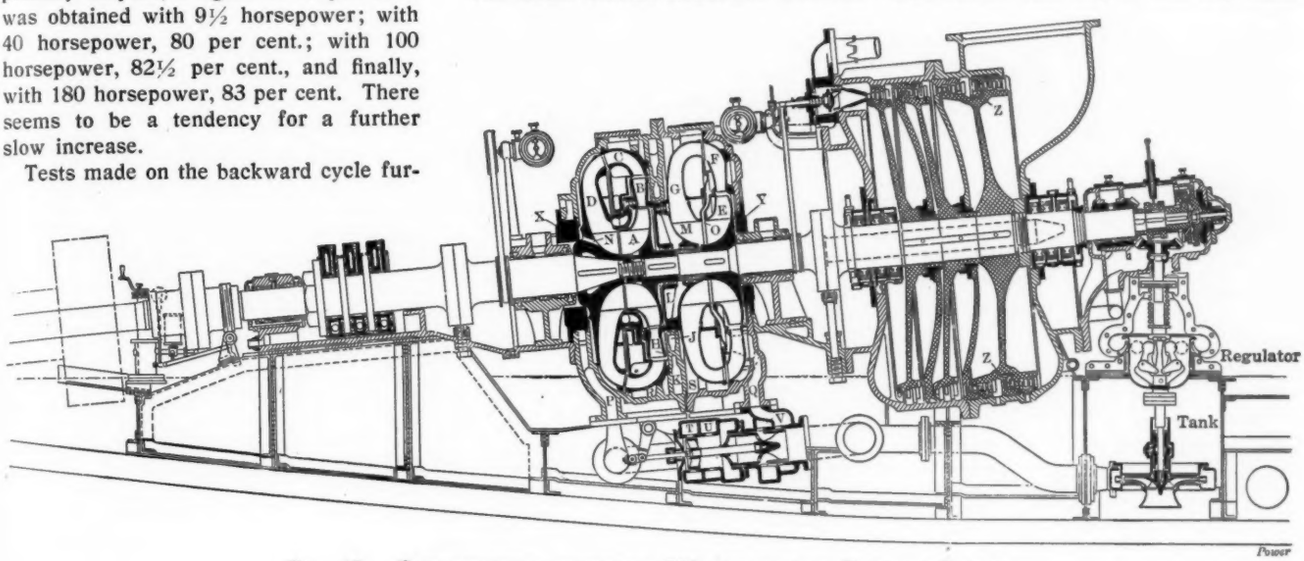


FIG. 10. CROSS-SECTION THROUGH 500-HORSEPOWER TURBINE PLANT

Uncle Pegleg's Philosophy

Showing the Value of Practical Knowledge When It Comes to Starting an Engine and How One of Uncle Pegleg's Friends Made Easy Money by "Knowing How".

Under Uncle Pegleg's tuition I was getting along pretty well in the engine room. He had let me "start her up" for quite some time and had finally got me so that I could stop her without getting her on the center, and without backing her up and running off all the quarter-turn belts in the mill, and I was beginning to feel quite chesty. On the day that I thought I had him cornered about that two-thousand mile lump of coal thing I went over to set her going, but she wouldn't budge. I worked the throttle and the starting bar just as I had done for days before, but she only sat there like a balky mule. There was plenty of steam, the crank stood just above the head center, everything was all right as far as I could see, but something seemed to be holding the flywheel tight. I went over to the wheel pit to see that everything was clear and Uncle Pegleg stumped over to the engine, and when I came back said with a grin, "Try her now."

I did, and she went off beautifully.

"It's all right," he said, "to follow up the theory of steam engineering, but you don't want to forget the practical end of it. All the theory on earth won't run a sawmill, and running mills is what engineers get paid for."

I had an idea that the old man had put up a job to take a little of the cockiness with which I had gone for him on the coal question out of me, but I couldn't see yet what he had done.

"What was the matter?" I asked.

"That reminds me of some easy money that Jim Benton made one time down South," chuckled my patron, with seeming irrelevancy. "You see, Jim he had a fair-to-middling job in a cotton gin or oil mill or something, and they put up a big cotton mill in a town nearby. Jim used to go and look the job over at odd times and chin with the fellow who was erecting the engines, and finally he put in a bid to run her.

"'How much do you want?' says the boss.

"'A hundred dollars,' says Jim.

"'What! a year?'

"'No, a month,' says Jim, 'and overtime.'

"'Humph!' says the old man, 'a dollar and a half a day would be high living for you,' and he walks away.

"Well, it was partly Jim's fault. If he had got a shave and a shine and put on a boiled shirt and looked a little more like the salary he was striking for he would have been more likely to get some kind of consideration, but he always carried the engine room around with him, and a pretty slouchy engine room at that. It's all right about the clothes not making the man, but if a fellow makes himself up like a laborer and talks and acts like a dollar a day it ain't much use of dubbing him a professor because he knows how to run an engine. Well, they had several arguments about the matter after that, but Jim wouldn't come down to their terms, and I guess they weren't very anxious, for it was a gilt-edged outfit and Jim didn't pretty up to the surroundings. Anyhow he heard just before they got ready to start up that they had hired another man.

"This mill was going to be a great thing for the town and for the South, 'bringing the spindles of the North to the heart of the cotton fields,' and all that sort of thing. There was to be a lot of ceremony and a banquet in one of the mill rooms, and the stockholders and officers and city officials were to be there, and the mayor was going to start up the big engine with a 'few well chosen words' about the promise and potency of the occasion, and there was to be a brass band and high jinks; but along toward noon when everything ought to be all ready, up comes the new engineer to the boss and says:

"'Mr. So-and-so, there's something the matter with the engine; she won't turn over.'

"'Won't turn over? What's the matter with you?' says the boss, all excited. 'She ran like a deer for the engine company's man. What you been doing to her?'

"'I haven't done a thing, Mr. So-and-so,' says the engineer, helpless like, 'except to turn on the steam, and she won't start. I haven't changed a thing, don't know what to change, but she simply won't go.'

"Here was a pretty pickle. The guests were there being shown through the mill. The girls in their white dresses were putting the last touches on the banquet table upstairs. The boss rushed to the engine room with his new engineer, saw that steam was up, that all the valves were open, saw the new man fidget and pump with valves and levers, but the engine just sat there. He called for everybody around the place who knew anything about mechanics, but none of them knew what to do. He hopped into his buggy and started off for every place in town where there was an engineer, but none of them wanted to tackle a compound-condensing Corliss. There was one recommendation, though, that they all made to him: 'Get Jim Benton; he can start her if anybody can.'

"Finally, in sheer desperation, he sends back word to the mill to let the banquet go on without him and off he puts to find Jim. When he gets to Jim's place he goes to his boss and says:

"'Say, I'm in a fuss over to the mill; got a lot of company to see it run and the engine won't go. Can I have your man Benton for a while? They say he can start it.'

"Jim had an understudy on the job, so the boss, wanting to be neighborly—though he wasn't invited to the banquet—says, 'Sure,' and Mr. Manager pikes out after Jim. He's cleaning out a boiler and he's full of soot and grease from his shoes up.

"'Say, you,' says the manager, 'Mr. So-and-so says you can go over to the mill and help me out; we've got some trouble with the engine.'

"'So?' drawls Jim, 'what's the matter?'

"'If I knew I wouldn't be here after you. Come, hurry up. The mayor's waiting to start her. Shake off those togs and hop in with me. My rig's outside.'

"'What is there in it?' asks Jim, not a bit excited.

"'What do you mean? Oh, I'll make it all right with you. Come, hurry up, we're late now.'

"'How much?'

"'Five dollars. That's pretty good for a few minutes' work and an afternoon off, ain't it?'

"Jim sniffed contemptuously, turned the steam onto his blower and commenced to stir up a shower of soot.

"'Well, how much do you want? Will you please get out of those dirty duds and come along? We can fix the price on the way.'

"Jim shuts off the steam and comes out of the cloud. 'Lookee here, Mr. So-and-so,' says he, 'this celebration of yours is going to be knocked into a cocked hat just for want of a real engineer. An engineer ain't much account to you folks ordinarily, only about a dollar and a half's worth, but now you've got to have one. I'll go over and start that blooming old machine of yours for fifty dollars, and I'll do it inside of ten minutes after you land me there if it can be done at all. If I don't, it won't cost you a cent.'

"'Fifty dollars!' gasps the manager, 'for ten minutes' work? It's preposterous. What are these laborers coming to?'

"Jim turns on the steam.

"The manager was frantic. He bounced back to the office and tried to get Jim's boss to make him go, but the boss said it was up to Jim. He came back pleading.

"'Ah, gwan,' says Jim, 'you don't want

no engineer; you want a laborer,' he says, and goes on squirting soot over himself.

"Well, finally after much persuasion Jim agrees to go for fifty dollars and they drive off.

"In the meantime things have been dragging somewhat at the mill. They've kept them at the table as long as they could and had their speeches and music, etc., but the crowd has drifted around to the engine room, and when the manager drives up with his horse all winded and up, slides back to the mayor and whispers, 'All right, Gov'ner, start in your spiel. She'll go when you're ready.' Then he knocks on the cylinder head with a wrench for silence and the mayor gets off his few extemporaneous remarks that had been weighing on his mind all day; and when he came to 'And now, my fellow citizens and distinguished guests, it becomes my proud privilege to open for the first time this throttle and to put the breath of life into this mighty implement out into the boiler room and hung around until he got hold of that new engineer and showed him how the governor was arranged with safety cams that came into play when the governor was way down and kept the valves from hooking on, and how the engine wouldn't start until you had lifted the governor and put a pin under it to hold it up so the cams would let the valves open. He wanted to give good measure for his fifty, or else he didn't want to be dragged over again the

"All Right, Governor, Start in Your Spiel. She'll Go When You're Ready

frothy and he and Jim, all sooty, greasy and slouchy, burst into the engine room, they find the polished and beflagged machine surrounded by an impatient throng and His Honor demanding in imperious tones, 'What t'ell's the hold up?'

"They make way for Jim, who goes straight for the starting bar, gives the wristplate a wriggle, looks up at the governor, grins, goes and lifts it and puts the pin under, sees that she is warmed of industry which shall furnish the power to operate the shafts which shall turn the spindles, which shall furnish employment to untold thousands of our inhabitants and bring to our midst contentment and prosperity,' the 'mighty implement' started off without a whimper while the crowd cheered and the band played Dixie, and Jim, down below, threw her over onto the condenser.

"He didn't come up again but slunk next day. You never could tell about Jim.

"If you're going to forget anything, you'd better forget to put the pin in when you're stopping than to take it out after you get started, because the governor belt may break some day or a pin come out of the gear, and if those safeties aren't working I may not be able to shut her down in time to save her. I ain't as spry as I was once."

In the discussion of the effect of superheated steam upon cast iron by the New England members of the American Society of Mechanical Engineers, a couple of months since, microscopic analysis was referred to and some photo-micrographs of samples shown. In discussing a report of one of its committees on the properties of alloys before the Institution of Mechanical Engineers of Great Britain recently, Professor Arnold of Sheffield drew attention to the danger of placing too much reliance on micro-analysis. Few men have made a more exhaustive study of steel by this method than he, but his researches and comparisons of failures arising from alternating stresses have convinced him that there is something beyond what can be seen by a microscope which has to be considered.

As an example again of the danger of engineers placing too great reliance on a simple cold-belt bending test he instanced some tests which he had made to show how variable were the results obtained when bars were subjected to exactly similar alternating stresses. Similar sized bars, for example, ranged from 168 to 872 alternations, thus showing wide variation in quality, yet all bent double cold without any sign of flaw. The tests seemed to show that in the breaking down of materials under stress, forces and causes are in operation which metallurgists and engineers are only dimly beginning to understand.

The Selection of an Engine

To Drive 150- or 200-kilowatt Generator Simple Four-valve Engine Allotted Choice over High-speed Corliss, Tandem Compound, Vertical Marine Compound and the Turbine

Warren H. Miller, a frequent contributor of POWER, tells in a recent number of the *Engineering Record* how the prime mover was selected for a works having electrical distribution.

There are four ways of driving the power generators by steam, each possessing peculiar advantages of its own, so bids were asked on engines to drive 150-kilovolt-ampere generators on 85 per cent. power factor from prominent makers of high-speed Corliss or four-valve engines, high-speed horizontal tandem compounds, high-speed vertical marine compounds and steam turbines. Alternate bids were also asked on the types in 200-kilovolt-ampere sizes, and in both cases steam-consumption guaranties were requested on 100, 80 and 50 pounds of steam, with 26-inch vacuum, atmosphere, and four pounds back pressure. This move was made principally to bring out what the turbines would do under adverse conditions of low steam and back pressure when the exhaust was being used in the process.

The results and prices for all classes of engines are given in the tables. Only bidders of the highest class were invited to furnish tenders, so the letters in the columns of manufacturers represent some of the best-known names in American engine practice.

Probably for minimum floor space, ability to stand wet steam and water hammer and unlimited capacity for carrying overloads, the marine compounds stand at the head. Coupled to water-wheel type generators, they take about the same floor space as a turbine. A very good feature is that all the moving parts are light, and can all be repaired and replaced in the engine the same day any trouble occurs, whereas the heavier horizontal engines usually make a more lengthy matter of any serious breakdown. If a turbine runs out of balance and chatters so that no foundation bolt can hold it down, it is a still longer and more serious job to get it balanced and back into running order. As shown by the tables, the cylinder ratio is 1:4, following standard marine practice for 100 pounds initial pressure. This has the double advantage of the economy of a 1:10 rate of expansion for ordinary cutoffs, and, in case of heavy overloads, the cutoff retards as the engine slows down, until the receiver pressure climbs up to almost 10 pounds, thus nearly doubling the power of the low-pressure cylinder.

Its high cost was, however, seriously against it, and, moreover, the oiling facilities of this type of engine for electric service have not been brought to such a high state of perfection as with land engines.

Among the high-speed Corliss engine makers, A, C and D were eliminated,

DATA REGARDING HIGH-SPEED CORLISS OR FOUR-VALVE ENGINES.

Maker.	Horsepower.	Bore and Stroke.	R. P. M.	K. V. A.	Price.	100 Lb. Steam. 26-in. Vac.	100 Lb. Steam. Atm.	100 Lb. Steam. 4 Lb. B. P.	Main Bearings.	Weight.	Price with Gen. A.	Price with Gen. B.
A	242	18x30	150	200	$3,720	....	..	....	9x18	.....	$6,838	$6,895
A	152	16x30	150	150	2,826	....	..	....	8x16	.....	5,610	5,421
B	200	20x19	150	200	4,095	24.3	..	26.9	....	39,500	7,213	7,270
*B	200	18x17	180	200	3,560	24.3	..	26.9	....	29,650	6,727	6,510
C	200	16x30	150	200	3,100	....	..	....	9x11	46,000	6,218	6,270
C	150	14x30	150	150	2,407	....	..	....	8x10	34,000	5,191	5,002
D	200	16x36	150	200	3,400	....	24	28½	8x16	40,000	6,518	6,575
D	150	14x36	150	150	3,200	....	24	28¼	8x16	36,000	5,989	5,795

*Winner.

DATA REGARDING HIGH-SPEED MARINE COMPOUND ENGINES.

Maker.	Horsepower.	Bore and Stroke.	R. P. M	K. V. A.	Price.	100 Lb. Steam. 26-in. Vac.	100 Lb. Steam. Atm.	100 Lb. Steam. 4 Lb. B. P.	Main Bearings.	Weight.	Price with Gen. A.	Price with Gen. B.
A	200	14&28x16	180	200	$6,060	....	..	....	....	....	$8,526	$8,610
A	150	12&24x12	180	150	5,080	....	..	....	....	.....	7,548	7,530

DATA REGARDING HIGH-SPEED TANDEM COMPOUND ENGINES.

Maker.	Horsepower.	Bore and Stroke.	R. P. M.	K. V. A.	Price.	100 Lb. Steam. 26-in. Vac.	100 Lb. Steam. Atm.	100 Lb. Steam. 4 Lb. B. P.	50 Lb. Steam. 4 Lb. B. P.	Main Bearings.	Weight.	Price with Gen. A.	Price with Gen. B.
A...	200	16&26½x18	180	200	$5,250	24.6	..	31	..	..	46,000	$8,117	$8,200
A...	100	14&24x16	180	150	4,095	24.6	..	31	..	....	35,500	6,563	6,545
B...	215	13&21x22	180	200	4,225	....	..	..	..	9x17	38,000	7,095	7,157
B...	165	13&21x18	180	150	3,800	....	..	..	..	8x17	33,300	6,268	6,250
C...	240	16&24x18	180	200	3,848	....	..	..	..	....	38,000	6,316	6,298
C...	150	13&20x15	180	150	2,282	....	..	..	..	....	18,000	4,750	4,732
D ..	215	13&24½x21	180	200	3,460	17	21	..	..	9x18	40,000	6,327	6,410
D ..	150	[illegible]21	180	150	3,005	17	21	..	..	7½x16	30,000	5,473	5,455

DATA REGARDING TURBINES.

Maker.	Horsepower.	Bore and Stroke.	R. P. M.	K. V. A.	Price.	100 Lb. Steam. 26-in. Vac.	100 Lb. Steam. Atm.	100 Lb. Steam. 4 Lb. B. P.	80 Lb. Steam. 4 Lb. B. P.	50 Lb. Steam. 4 Lb. B. P.	Weight.	Price with Gen. A.	Price with Gen. B.
A	200	..	3,600	200	$5,300	29	36.4	43.5	...	....	.....	.....	$5,300
A	150	..	3,600	150	3,650	30.5	38.0	45.2	...	....	.....	.....	3,600
B	200	..	1,800	200	4,200	....	51	....	91½	116½	13,700	.....	4,200
B	150	..	1,800	150	3,385	....	46½	....	95	121	11,600	.....	3,385
C	150	..	3,600	150	3,900	30	Drops to 75-kw.	Will not consider.			14,500	$3,900	.....

principally because their piston speeds were too high, 900 feet for D and 750 for A and C. The 16-inch diameter single cylinder did not appeal to us either, even though it figures out all right at that high piston speed. It simply meant that the engine would lie right down on low steam or high back pressure or heavy overloads, simply for lack of driving power in the piston itself. The 16 and 24 by 18-inch and 16 and 26 by 18-inch compounds would be much better off in this respect, having their low-pressure cylinders to fall back on in case of low steam; and as this latter ailment is more or less chronic about large, overdriven, overrushed industrial plants, working nights, days and Sundays to keep up with orders, it must not be left out of the reckoning in selecting the engines which are to make the works go.

The next things to be eliminated were the turbines. Where the steam was to be rejected into a good condenser, giving 28 to 29 inches of vacuum, they would most likely win out, as the prices show up well below those of good engines. Most of the defects that afflicted the earlier models of small turbines have been driven out, and the 100-kilowatt and larger impulse turbines seem to have come to stay. A thorough investigation of the whole process of manufacture of two of the largest companies making this type of turbine showed good substantial methods with due attention to likely weak spots, and the stories about their being subject to destructive blade stripping by water shots and the like proved to be generally due to some special cause back of the failure.

They will not, however, stand continuous overload, nor loss of vacuum, nor back pressure. One of the big companies refused to bid at all on the back-pressure conditions of four to eight pounds, and stated frankly that at atmosphere its turbine would lose nearly half its power. With low steam the turbine will not only lose heavily in speed, but will waste great quantities of steam through the extra nozzles which must be turned on, and this at the very time the firemen are nursing every pound of steam to gain on the pressure and get horsepower enough for the load without boiling all the water in the plant.

In the special case of this works, there were both back pressure above atmosphere and low steam to be reckoned with. Everything would go along nicely with the turbines until the process called for four pounds back pressure. At this the steam consumption per horsepower would rise to 45 pounds, or 1½ boiler horsepower, which would promptly pull down the pressure of the power section over in the boiler house. Then, with steam dropping, the steam consumption of the turbines would steadily rise, till at 50 pounds, nothing unusual, it would reach the enormous figure of 116½ pounds, or 800 boiler horsepower to drive 200 horsepower of turbines. As 500 horsepower was the limit set aside for the electric-power section, one could foretell squalls ahead with considerable certainty.

There remained the tandem compounds and bidder B of the high-speed Corliss. This maker offered a four-valve simple engine, side crank with splash-oil case, 20 inches bore by 19 inches stroke at 180 revolutions per minute for the 200-kilovolt-ampere generators, and 18x17 inches at 150 revolutions per minute for the 150 kilovolt-ampere.

The first argument against the tandems was their high price, running from $7000 to $8000 for the best makes. B and D among them were let out because of the small cylinders offered, while A, having a magnificent engine, was too expensive; so the contest narrowed down to B of the four-valve simple engine and C of the tandems. As the four-valve runs easily at 200 to 225 revolutions per minute, there was no objection to raising the 18x17 inches to 180 revolutions per minute, thus making a 200-kilovolt-ampere generator driver out of it, and making the price $6500 against $6300 for the tandem. In favor of the four valve could be urged its greater simplicity, its excellent and reliable oiling system, and the absence of two sets of piston and valve rods to keep packed, two sets of piston rings to renew, and two sets of valves to keep in order. The reputation for excellence of workmanship of its builders was also slightly in its favor. In behalf of the compound tandem were its greater economy and greater capacity in times of overload.

It lay almost for individual preference to decide, but then entered the considerations of running condensing, atmospheric and with four pounds back pressure, and the simple four valve carried the day. For there is little use for a compound running at atmosphere. At four pounds back pressure, it is positively in its own way, and its multiplicity of parts is a grievous burden, whereas the simple engine will worry right along under these conditions, or one can adjust the valves to suit the change in a very few minutes if the back pressure is going to be wanted for several days at a stretch, or even for a shorter period.

Buying Coal on a Horsepower Basis

In the *Journal of the Worcester Polytechnic Institute* for January, Wallace C. Rogers presents a few objections to the much advocated scheme of buying coal upon the B.t.u. basis. All determinations are based on an analysis of a sample consisting of a quart of coal taken from a carload of forty tons or from a cargo of several hundred tons. One small piece of foreign matter in the sample is sufficient to throw off the entire analysis.

The purchaser pays a higher price and gets the inferior coal when buying on a B.t.u. basis. If the seller has to guarantee something which depends upon nature, he naturally expects to get paid for it and paid well. A clever coal salesman tried to sell a prominent firm on the Hudson. The manager confronted the salesman with a pamphlet containing several tables of penalties and asked him to bid on a certain amount of business. The salesman after a careful study of the tables guaranteed the very best grade of coal with a high B.t.u., excellent analysis and a correspondingly high price. He got the order, shipped the very poorest and cheapest coal he could buy, took all the penalties and made money.

The buyer argues, "It is heat units I am buying; it is the B.t.u. I want." Mr. Rogers asks, "Then why don't you buy a cheap gas coal that is absolutely useless as a steam coal, yet runs higher in B.t.u.?"

It is horsepower that the buyer wants, not B.t.u. Then why not buy his coal on a horsepower basis instead of a B.t.u. basis? An analysis is useful in many ways, but it will not determine how much steam a certain grade of coal will make under a particular boiler. This can be determined only by a thorough run on the coal. The measure of coal efficiency should be cost per kilowatt-hour for the electrical engineer, cost per horsepower-hour for the mechanical engineer and cost per unit of production for the manufacturer.

Another case of admitting steam to a boiler with a man inside recently occurred in Cleveland. One of the employees while at work inside of a boiler at the Teachout boiler works, was seriously scalded when someone accidentally turned a valve, filling the boiler with steam. As a result the man will probably be blind. Unable to find his way out through the blinding steam that enveloped him, he hammered on the side of the boiler and cried for help. He was heard by fellow employees at the plant and the steam was quickly turned off. He was assisted out of the boiler and attempted to walk to his home, but soon collapsed and was taken to his home in an ambulance.

Condenser Tubes and Circulating Water

BY NATHAN OWITZ

The saving made by the installation of a condensing outfit is generally well worth the first cost of putting the apparatus in the power plant.

The probable cost of operation is more speculation on the part of the engineer or plant owner than fact, as the assumption is that the bill for repairs cuts down the saving considerably. This is not so, for the repairs demanded by a condenser outfit are hardly worth mentioning; furthermore the condenser manufacture sells his apparatus under a specific guarantee. and also promises to replace any material proving to be defective within a certain period, generally one year.

While the repairs amount to but little in comparison to the saving, still there is one item in connection with condenser operation that has given considerable trouble to the operating engineer, and has been given the sole attention of condenser experts and manufacturers, i.e., the proper kind of tubes to use. Most of the builders of the standard type of condenser specify brass tubes; often copper, as they are believed to be the best kind of tube to resist corrosion, but in many instances these have failed and been found to be worthless. This has been due to the circulating water used containing foreign matter, chemicals, etc., which made the brass tube liable to corrosion, thus diminishing the heat transference and thereby making the condenser unable to live up to the guarantee given by the manufacturer. The tubes will pit, and clogging is bound to take place, thus preventing the circulating water from passing through the tubes; and the condenser, being unable to handle the incoming steam, will very naturally fail to produce satisfactory results.

Kinds of Tube

When a manufacturer figures on a condensing outfit, he will, to the best of his knowledge, put in the kind of tubes best suited to that particular installation, taking into consideration the quality of circulating water to be used, getting an analysis if possible, so as to be able to know just what kind of tubes to use, whether brass, copper, tinned, etc.

Brass tubes are mostly used, while copper tubes are a close second, and for general purposes, where fair conditions prevail, such as good circulating water, etc., they are perhaps the best, but when it comes to water that corrodes the tubes, the condenser manufacturer is "up against it." For such cases, aluminum-lined tubes are often used to very good advantage, while a brass or copper tube, tinned inside and out, often overcomes the difficulties.

Glass tubes were once thought to be of some use, but experimenting showed that they would not stand the difference of temperatures between the inside and outside of the tube. Even though they were made of a sufficient thickness, it was shown that they would not serve the purpose; for while they would not crack, when thick enough, they interfered with the heat transference. Extensive experiments were made with hard-rubber tubes, and for a time it was thought that the proper tube was at last found, but they were cast aside on account of their high cost, and because the heat transference was interfered with.

Enameled tubes were then tried, that is, a tube enameled on the inside, but they would crack and the enamel chip off due to the expansion and contraction; the heat transference was also impaired. Cast-iron and steel tubes were laid aside on account of their easy liability to corrosion. Varnished tubes were used for a time, a metal tube varnished on the inside with a specially prepared paint; but the result was a failure, due to the varnish cracking and splitting, thus exposing the metal of the tube to the circulating water.

Tubes that were lacquered and treated with a coating of special mixture gave no relief, as the coating would easily crack and scale off. Tubes made of the so-called "white metal" were tried also; that is, a tube made of a composition of lead, antimony and tin, and sometimes a little zinc was added, but these proved no better than the others, for the metal was too soft for service, and deterioration quickly followed.

Which is the best tube for practical commercial use is a matter not easily answered. First, it is a matter of personal opinion; then again the matter of corrosion comes up. In one installation where one type of tube was in service, the engineer found that they lasted several years and naturally if asked for his opinion as to the best tube, he would recommend these tubes. Again, where this same kind of tube failed, tinned-brass tubes were installed to the entire satisfaction of all concerned. In another instance, where the tinned tubes were declared worthless, tubes of another mixture were put in and found to be just the tube. In some cases one kind of tube is good, in some another, and naturally an engineer, using a certain kind of tube with good results, will be of the opinion that that kind of tube is the best, and especially so if he has had trouble with tubes of different metal and mixtures.

In some stations condenser tubes will not last more than two or three years, sometimes not even that long, while under more favorable conditions the tubes will last for eight, ten and twelve years, and this, too, with very little attention being paid to them. I know of several cases where tubes have been in service for the past sixteen years and show no signs of distress.

Many condenser experts believe that the best tube for commercial purposes is one made of chemically pure copper and as a close second, a chemically pure brass tube. Many are of the opinion that a brass or Muntz metal, or even copper tube, tinned on the inside and outside, is as good a tube as can be used.

Accumulation on Tubes

From various reports handed in by chemists and condenser-tube experts there is no settled opinion of just what causes sediment to cling to the inside of the tube. The causes of galvanic action and electrolysis have been discussed time and time again, with a result that is far from satisfactory, and understandable. We know that matter contained in water will cling very readily to metal; still there is something more to be discovered to explain just what causes this matter to accumulate more on certain substances than on others. We know that water will have a different effect on brass than it will on copper, and that the effect on tin is different to that on brass, and copper and tin, etc., also that corrosion will take place in one case and not another where the same conditions prevail; but we have not arrived at any definite conclusion as to the best metal tubes to be used to prevent corrosion.

Cleaning Tubes

When condenser tubes corrode or get clogged with matter, several methods are employed to clean them out. Similar to the cleaning of boiler tubes, the energy spent in cleaning condenser tubes is always worth the effort, compounds and chemicals, mechanical devices, such as tube cleaners, tube brushes and drills, and a case or two of a blowing-out arrangement being used; compounds and mechanical devices are mostly used.

If an accumulation of sediment remains on and in the condenser tubes it will produce a low vacuum, and as stated by a few engineers, that "if all the matter does not come out, the tubes have an excellent chance of clogging up again in a very short time, because the little that is left behind helps the clinging qualities of the new matter, and gives it something to hold on to."

The mechanical cleaning devices, of which there are a number on the market, are of several types. Some are of the straight-cut arrangement, while others are made so as to rotate inside the tube, cutting loose the matter inside, which is very often as hard as rock, and pushing it out.

The drill that is used to clean condensers is a very simple thing. It is a rod, as long or longer than the tube to be cleaned, and has a flat, sharpened end, so that when the drill rotates it cuts out the inside matter. The cost of both kinds of cleaners is about the same, the mechanical cleaner perhaps a little more expensive, according to the make. Tube brushes have been used with fairly good results. The brush is made of very stiff wire, and has a handle on one end, so it can be fastened to a cord or wire and pulled through the tube. It is available where the scale is not hard. While the matter of compounds is treated very lightly, and they do not get the credit that is due them, in several instances they have proven the best of all remedies. There are several manufacturers of compounds who are willing to guarantee their article to do the work, with the agreement and understanding of—"no work, no pay."

While the matter of the tube is a sort of a drawback to the operating engineer, it ought never to stand in the way of an intended installation, for the matter is so small in comparison with the saving of a condensing unit, and the benefits to be derived from such an installation, that this point should overrule all objections due to the tube. A proposed installation should never be held up on this account, and the supposed large bills for repairs should never stand in the way.

A Large Surface Condenser

Base Condenser with Deflecting Plates and 25,000 Square Feet of Surface Designed to Maintain Vacuum of 28 Inches and Condense 236,000 Pounds of Steam per Hour

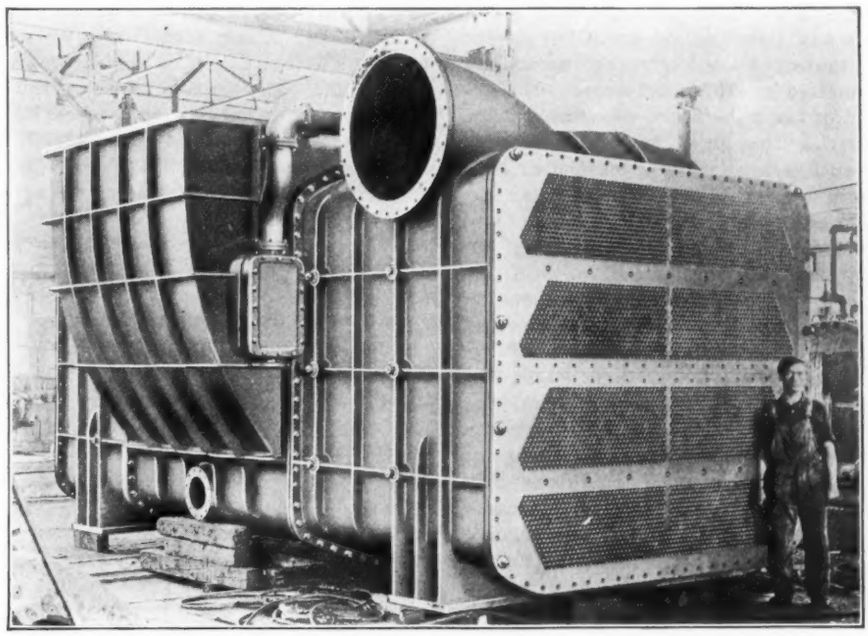
Steam-turbine development has acted as an incentive to development in several lines of power-plant machinery, not the least among which is the surface condenser. In the earlier turbine installations a cooling surface in the condenser of 4 square feet per kilowatt capacity of the generator was considered imperative for satisfactory operation. This provided for the transmission of about 200 B.t.u. per hour per square foot of cooling surface for each degree of temperature difference between the water and the entering steam.

By inserting thermometers in the several water passes of the conventional surface condenser it was found that the most of the heat transmission was accomplished in the upper rows of tubes, and that the lower rows, being showered with the warm water from the upper ones, aided but little in the condensation. The circulating water instead of condensing steam only cooled water from the upper rows, and the transmission of 300 B.t.u. per hour was considered the limit of thermal conductivity.

By the introduction of water sheds or plates each of which caught the condensation from a few rows of tubes and conducted it to the side of the shell where it ran to the bottom, the surfaces of most of the tubes, unhampered by a water envelop, were brought in contact with the steam to be condensed, with the result that 1000 B.t.u. per hour per square foot of cooling surface per degree of temperature difference were easily transmitted instead of only 300 as formerly; and the end is not yet, for this latest step in the increase of heat transference, though a wide one, is probably not the last. Among the first American makers to use the system of water-deflecting plates was the Wheeler Condenser and Engineering Company, one of whose recent productions is shown in the illustration. It is a base condenser for a double-flow Westinghouse turbine designed to maintain a vacuum of 28 inches while condensing 236,000 pounds of steam per hour. It has 25,000 square feet of cooling surface, of which 524 are included in the feed-water heater. In design it is symmetrical, the diagonal view showing one of the two large rectangular openings for steam admission in which are located the feed-water heaters which are simply small condensers placed in the path of the entering steam. They are connected by the feed pipe passing over the top of the shell directly back of the opening for the atmospheric exhaust.

Throughout the shell, from top to bottom, between the rows of tubes, at frequent intervals are water-shed plates which collect the condensation and carry it to the side of the shell away from the tubes, thus presenting a large proportion of so-called dry tubes to the entering steam.

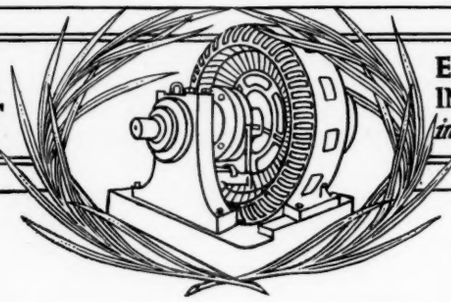
As air is considerably heavier than the steam entering the condenser, the dry-vacuum pump connection is placed near the bottom of the chamber toward which the air naturally gravitates, as well as being also driven in this direction by the downward rush of the entering steam.



DRY-TUBE SURFACE CONDENSER WITH 25,000 SQUARE FEET OF SURFACE

The per capita consumption of coal has been more than keeping pace with the increase in production. In other words, coal is being used in the industries at an increasing rate, which is represented by the use for 1880 of 1.4 tons per capita; 1892, 2.3 tons per capita, and 1907, 5.4 tons per capita per annum.

ELECTRICAL DEPARTMENT



ESPECIALLY CONDUCTED *to* BE *of* INTEREST *and* SERVICE *to the* MEN *in* CHARGE *of the* ELECTRICAL EQUIPMENT

Testing Transformers

By J. W. Himmelsbach

The ordinary transformer, perhaps more than any other one class of apparatus, requires frequent testing both from the viewpoint of economical operation and from that of the safety of the consumers whose lights or motors are connected to the transformers. The design of the transformer of today and the material used in it have been brought to such a high state of perfection that, under normal conditions of operation, the deterioration of the material is slight and the electrical characteristics change but very slightly. The internal losses of the transformer interest the central-station man the most, because they consume power without giving any monetary return, and it is to check these losses that every transformer in service should be tested at least every time its location is changed, and at more frequent intervals if suspicion or conditions warrant. For the sake of the consumer's safety, the insulation resistance should be checked quite as frequently; no plant manager should run the risk of injury to a consumer by reason of the deterioration or the breaking down of the insulation of a transformer.

The principal losses are the copper loss (loss in the transformer windings) and the iron or core loss. The former is important only when the transformer is loaded, but the latter goes on as long as the transformer is connected to the supply line whether the transformer is loaded or not.

It is a simple matter to determine the amount of these losses. The necessary requirements are a supply of alternating current, preferably three-wire, of the same voltage as the secondaries of the transformer to be tested, and of the frequency for which the transformer was designed (the circuit should have a capacity of at least 10 per cent. of the capacity of the largest transformer to be tested); a voltmeter with a double scale, for 150 and 300 volts; an ammeter and indicating wattmeter of such capacity that they will indicate on full scale 25 per cent. more than the full load of the largest transformer to be tested; a set of rheostats of sufficient capacity to control the exciting current, when the transformer is excited by the low-tension winding, and another set of sufficient capacity to control full-load current in the high-tension winding; a step-up transformer capable of delivering 10,000 volts, with taps brought out to vary the high-tension voltage in 10 per cent. steps. In place of a specially wound secondary, a water rheostat may be used for controlling the voltage applied to the secondary terminals of the testing transformer.

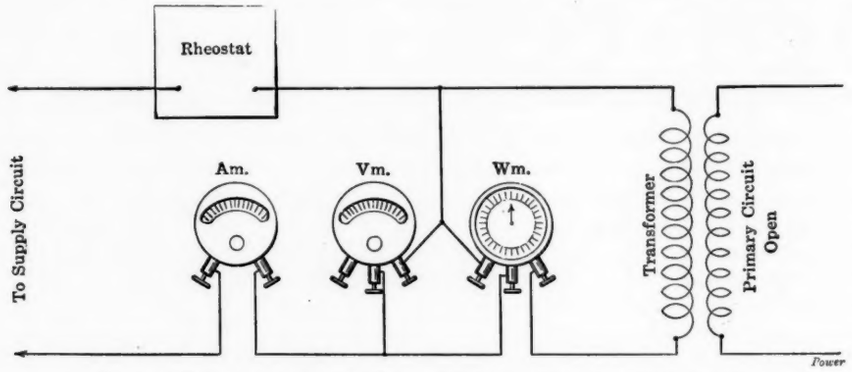


Fig. 1. Connections for Measuring Losses in a Transformer

When a transformer is brought in for test the first thing to do is to inspect it thoroughly for any mechanical injuries or defects visible to the eye, and any found should be immediately repaired. The next step is to test the insulation. For transformers wound for a primary voltage of from 2000 to 2500 volts, the maximum test voltage should not be less than 10,000 volts, applied for one minute between the primary and secondary windings and between the primary winding and the frame. This test should be applied, and if the transformer breaks down, the weak spot should be found and repaired, and the transformer tested again. This procedure should be continued until the transformer will stand the test. Between the secondary winding and the frame a test voltage of 2000 volts is sufficient for all standard types of transformers and should be applied in the manner just described.

The test next in order is that for iron losses. Connect the transformer as shown in Fig. 1, with the instruments as indicated. With the primary circuit open, adjust the voltage at the secondary terminals to its normal value and read the watts indicated by the wattmeter. This reading will be the iron losses of the transformer. If the core loss is within the allowable limits for efficient operation, the transformer may be connected up as shown in Fig. 2, and the copper loss determined. With the transformer connected as shown, the full-load primary current should be forced through the primary winding; the wattmeter will then indicate the copper loss plus a small core loss which, in a test of this kind, may be ignored.

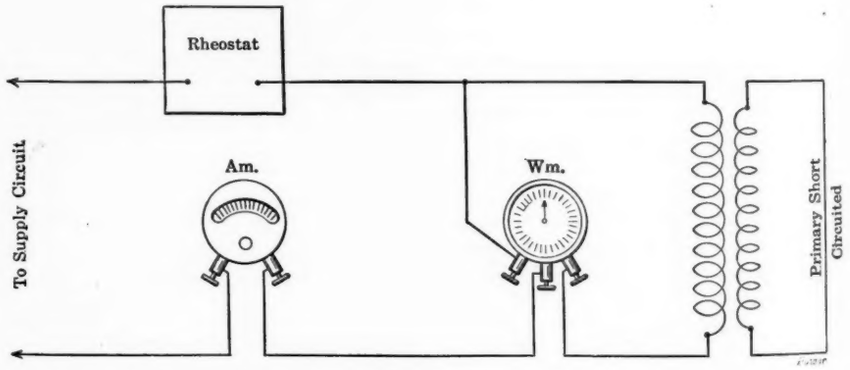


Fig. 2. Connections for Measuring Losses in Transformer Windings

The efficiency of the transformer may then be determined by adding the capacity in watts, the iron loss in watts and the copper loss in watts, and dividing 100 times the capacity by the sum of the three quantities mentioned. For example, suppose that the transformer is built for 110 volts and 10 amperes at the secondary terminals, then its capacity will be 1100 watts. Then, if the iron loss is 40 watts and the copper loss is 30 watts, the efficiency will be

$$\frac{100 \times 1100}{1100 + 40 + 30} = 94 \text{ per cent.}$$

An accurate record of all transformer tests should be kept, preferably on a card system. The form shown in Fig. 3 will serve to keep a detailed record of each transformer, its condition and location, and from it one can tell at a glance the complete history of the transformer.

SERIAL NO..... MAKE.....

Date of Test.	Test Results.			Date and Place of Installation.
	Iron Loss.	Copper Loss.	Efficiency.	

FIG. 3. SAMPLE FORM OF CARD TO RECORD TRANSFORMER DATA

Some Experiences of a "Trouble" Man

BY J. R. GRANT

While employed as trouble man for a large electrical manufacturing company I naturally had a large variety of experiences; some of the more instructive of them are described herein.

On one occasion I went to a large furnace plant to investigate troubles on two 250-kilowatt 110-volt compound-wound direct-current generators. The chief electrician informed me that the armature of one generator ran hot, even without load, and that the two machines would not parallel.

I started in first to run down the trouble with the defective armature. The engine was started and generator built up to normal voltage. In two or three minutes the armature began to smoke, and the machine was immediately shut down. I passed my hand over the armature and located the affected coils by their higher temperature; these were marked with chalk. The armature was extremely dirty and looked as though it had never been "blown out." After testing the commutator for grounds and finding none, I decided that the dirt and grease which had accumulated between the end connections had partially short-circuited the overheated coils. By the use of waste, some sharp sticks and a hand bellows we cleaned and blew out the armature end connections thoroughly. The generator was again started, built up to normal voltage and the armature showed no further signs of heating.

The next problem was to parallel the two generators. As the machines had been running together until a few days previous to this time and as no connections had been changed, we assumed that the polarity of one machine was reversed. While one generator was furnishing current to the busbars the other was started and built up to normal voltage. Upon inserting the voltmeter plug into the receptacle of each machine panel, the voltmeter pointer was deflected in the proper direction, and as everything appeared normal, I told the electrician to parallel the generators in the usual manner. Out went both circuit-breakers as though thrown by a short-circuit!

Further investigation revealed the fact that the switchboard voltmeter was of the alternating-current type, and consequently would not indicate polarity. As no polarized voltmeter was available we used an arc lamp. The readers may know that after an arc lamp burns for a few seconds and the current is switched off, the positive carbon remains hot the longer. In this way the polarity of both machines was tested and they were found to oppose each other, as originally suspected. After restoring the polarity of the reversed machine, it built up with correct polarity and was paralleled without difficulty.

The engineer, who evidently was not very well versed in electrical matters, remarked that everything appeared to be all right again but he "could not see what we had done."

At another time a small lighting plant was visited where they were having trouble in holding up the voltage of the alternator. The nameplates of the alternator and exciter were examined and the speeds of both checked up with a speed indicator. The switchboard instruments did not show the alternator overloaded. All resistance was cut out of the exciter and alternator field rheostats, and yet the lamps at the time of peak load were so dim that one could hardly find the way around the engine room.

Seeing the shunt strip in parallel with the series field winding of the exciter had not been disconnected, I asked the engineer why he had not taken it off so that series winding would get the full current.

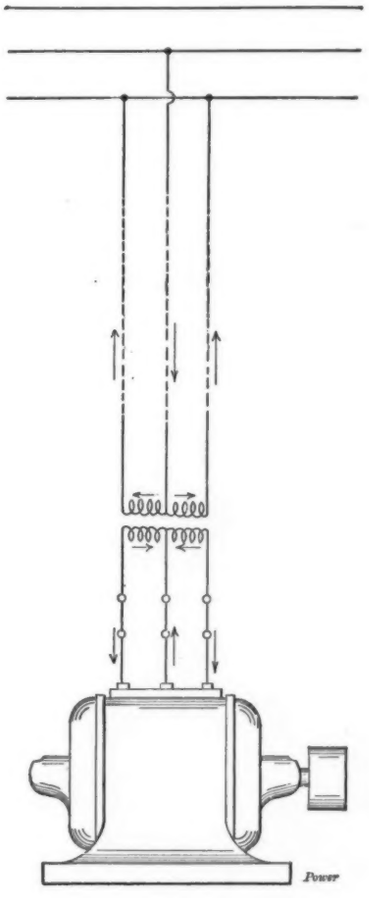


FIG. 1

This, he told me, had been tried, with the result that the voltage was lower than ever. No further evidence was necessary for me to know that series and shunt field windings must be "bucking" each other. When the series field connections were reversed and the shunt strip disconnected, we had voltage to spare on the alternator.

Upon further inquiry I learned that the exciter had been run as a compounded motor before it was used for an exciter. When making the transfer no connections on the machine were changed, hence the natural result that the field windings opposed each other.

Once I was sent in haste to a country town where the lighting plant was suffering a complete shutdown. The engineer told me that on the previous night the generator, an alternator, had "lost its voltage" and refused to generate further. Examination of the alternator dis-

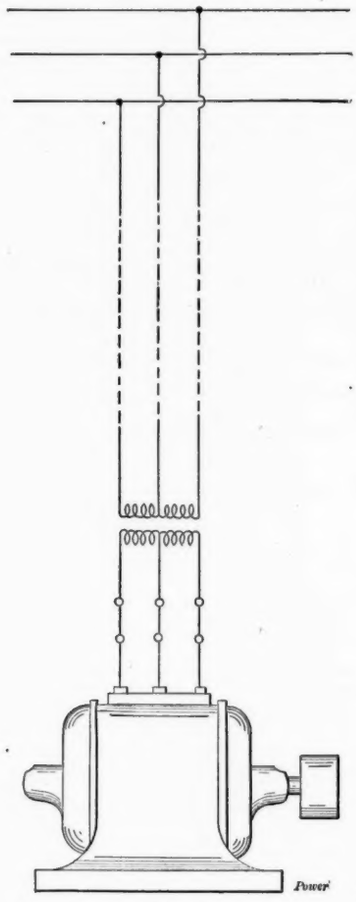


FIG. 2

closed no reason for trouble, and I was satisfied the trouble was in the exciter. With a magneto, which luckily was to be had, the commutator was tested, and a heavy ground was found to exist. A portion of the insulation between the outside clamping ring and commutator bars appeared to be carbonized. The armature was removed from machine and by the use of a sharp-pointed tool the charred insulation was dug out from under the commutator until the magneto showed no further trace of a ground. This space was then filled with asbestos rope packing, as no mica could be found in town. When the armature was replaced the exciter built up as usual, and so did the alternator. I advised the local manager that it would be wise to provide a spare armature in case of a similar breakdown.

A three-phase induction motor, fed by two transformers connected in open delta, refused to run. The secondary fuses were tested and found to be all right. Upon "nipping" the three-pole starting switch, a flash was obtained from each blade indicating the presence of current, but when the switch was closed the motor would only stand and hum. The primary fuses were tested and all of them found intact. A voltmeter, connected successively across the three phases, showed that two phases were of equal and normal voltage and the third phase appeared dead. This seemed an impossible condition on a three-phase circuit. When one primary fuse is out, full secondary voltage should show on one phase and half voltage on the two remaining phases. When one secondary fuse is out, voltage can be read on one phase only.

After some hard thinking it occurred to me that as there was equal voltage on two of the three phases, the lack of voltage on the third phase was due to the two transformers bucking each other. We followed the line to the junction with main line across town and there we found the lines connected as in Fig. 1. The transformers were opposing each other on the outside phase, as shown by the arrows giving the momentary direction of the currents. Careless work on the part of lineman had caused the trouble. After changing the line connection as in Fig. 2, the motor ran perfectly.

The exciter of one of the alternators of a small lighting and railway plant had burned out its armature, and as no spare armature was on hand, some method had to be devised to furnish current to the alternator field winding until the exciter armature could be rewound. It happened fortunately that in the station equipment there was a small railway generator kept as a reserve. By cutting in nearly all of the resistance of the field rheostat, the voltage was reduced to 125 without any objectionable results. After connecting a temporary jumper from this machine panel to the exciter panel and adjusting the voltage to 125 we connected the railway machine to the exciter busbars. When this was done the alternator voltage ran so high that the pointer on the alternating-current voltmeter went off the scale; the railway machine had to be disconnected from the busbars immediately to prevent burning out all the lamps on the circuit.

One mistake had been made. The series field winding was not cut out and the compounding, with the very weak shunt field, was enormous. The series field winding was then disconnected, the machine built up to normal voltage again and thrown on the busbars; it gave perfect service until the armature of the regular exciter was repaired.

An Interesting Optical Illusion

BY JAMES D. CARTIN

In the operation of an electric power plant with which the writer is connected the waterpower is developed at two plants close to each other. The generators in both plants are three-phase revolving field machines of the same size, speed and type. All of the feeder circuits from the different departments of the establishment are run to power house No. 1, each circuit being controlled by a double-throw switch which permits the furnishing of current for any circuit from either power house No. 1 or power house No. 2.

In distributing the load between the two power houses we very often find it necessary to supply current to the arc lamps which light power house No. 1 from the generator in power house No. 2. On such occasions I have observed that when the generators were running at exactly the same speed, the revolving field of the generator in power house No. 1 would appear to be standing perfectly still, the poles being easily counted. Upon a slight increase of speed of the generator in power house No 2 the revolving field magnet of the generator in power house No. 1 would appear to revolve backward, the apparent speed of rotation in the reverse direction varying with the difference between the speeds of the two generators. As the speeds are continually changing, due to changes in load, one gets the odd illusion in watching the revolving field magnet of seeing it apparently rotate first in one direction, then come to a dead stop, then reverse and rotate in the opposition direction.

For a long time I was at a loss to know what caused the machine to give this effect, but upon finding that it occurred only when the arc lamps were supplied from the generator in power house No. 2 it dawned on me that the imperceptible flickering of the arc lamps made impressions on the eye in synchronism with the No. 2 generator so that when the two generators were exactly in phase, the instants of maximum light occurred at intervals corresponding precisely to the movement of the magnet poles of the generator at No. 1 plant one step. Consequently, the poles being all alike, at each instant of maximum light the magnet poles presented exactly the same appearance to the eye that they had at the previous instant of maximum light, and therefore seemed to stand still. When the local generator was slightly behind the distant one, in mechanical phase relation, the moments of maximum illumination occurred earlier in the cycle of the local machine and gave the impression of backward rotation; con-

versely, a leading relation in the local generator caused its poles to move a trifle farther than one pole step in the intervals between the moments of maximum illumination, and this gave the optical impression of relatively slow forward rotation.

In watching moving pictures I have since noticed that when moving vehicles are shown the wheels at times seem to rotate backward with respect to the direction in which the vehicle is moving, presumably due to the same cause mentioned in the foregoing. Possibly some readers of POWER may have had a like experience. If so, I would be pleased to hear their views of the matter.

[The optical illusion described by Mr. Cartin is well known, and his explanation of it is correct. It indicates "hunting" on the part of one of the generators; that is, one of the field magnets swings back and forth with respect to the instantaneous position of the other. It would doubtless be of much interest to our readers if Mr. Cartin would explain how he ascertained that the relative speeds of the two generators were varying as described.—EDITOR.]

CORRESPONDENCE

Which Are the Best Synchronizing Connections?

In an electric-power station four alternators operate in parallel. The scheme of connections for synchronizing with the synchroscope is shown in Fig. 1. It will be seen that by inserting a four-point plug in the central group of holes of one of the eight-point receptacles and inserting a plug in the four-point receptacle of the synchroscope the necessary connections are made for synchronizing the generator corresponding to the eight-point receptacle used. Much trouble has been experienced from short-circuits and flashes at the receptacles while synchronizing. In some instances two generator panels have been plugged at once, causing a direct short-circuit through the plugs and always burning up the one last inserted. The blowing of the fuses in the plugs does not end the trouble because the current flashes across between the different receptacle terminals, destroying them as well as the plug. In one or two instances surges (apparently) have caused such flashes, and several men have been burned thereby.

To avoid this trouble there have been suggested three different schemes. One is to insert fuses in the wires leading from the generator leads to the plug receptacles and the other two are to change the synchronizing connections to those shown in Fig. 2 or Fig. 3. It will be seen that the last two methods require a synchronizing transformer for each generator. In Fig. 2 the plug closes both the primary and secondary circuits of the synchronizing transformer, while in Fig. 3 it closes only the secondary circuit. It seems that in Fig. 2 there would be no possible chance for a flash to occur as there are no points of opposite polarity near to each other, while in Fig. 3 the chances are remote since there are but 100 volts across the receptacle while the size plug is the same as is now used on the primary of 400 volts. The use of fuses would not prevent the flash but would limit its intensity, no doubt.

I would like other readers to offer comments on the preventive measures here described, or to suggest some better method of arranging the connections.

C. L. GREER.

Handley, Tex.

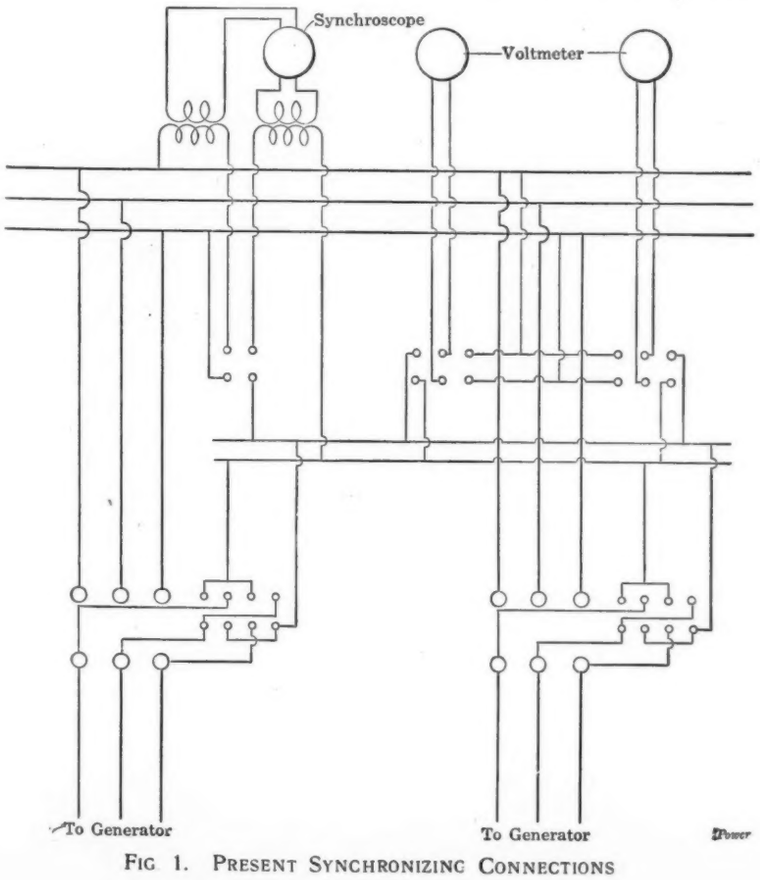


FIG 1. PRESENT SYNCHRONIZING CONNECTIONS

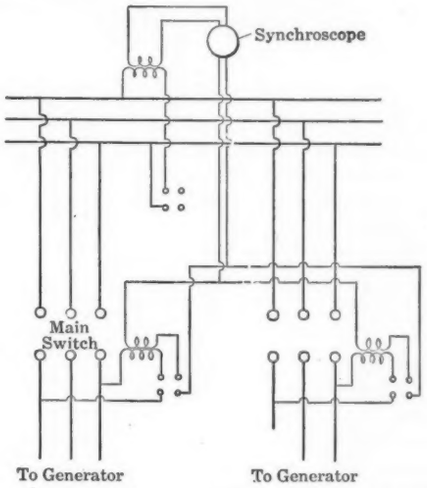


FIG. 2

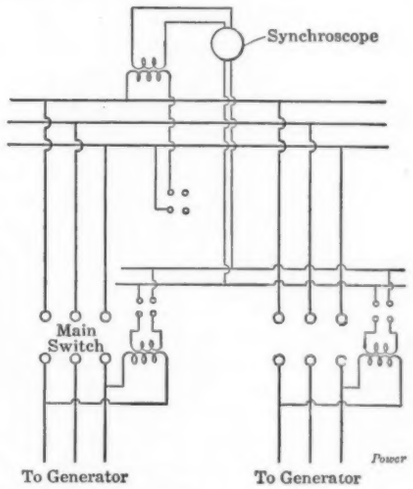


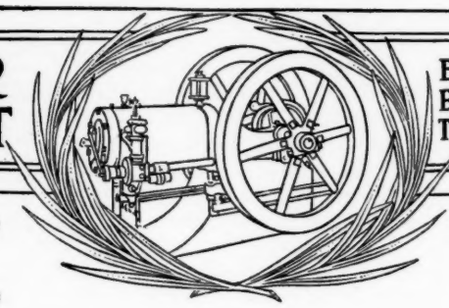
FIG. 3

PROPOSED SYNCHRONIZING CONNECTIONS

It has been reported that New England's total coal bill comes to about $100,000,000 every year. The most remarkable thing about this great bill is that about $70,000,000 goes toward freight and dealers' profits, whereas only about $30,000,000 was paid for coal at the mouth of the mine.

According to a recently issued Government report, the value of coal mined in the United States exceeds that of any other mineral product, and even clay exceeds gold.

GAS POWER DEPARTMENT



EVERY THING WORTH WHILE *in the* GAS ENGINE *and* PRODUCER INDUSTRY WILL BE TREATED HERE *for the* USE *of* PRACTICAL MEN

Operating Records From a Railway Gas Power Plant

In the issue of December 22, 1908, we published a complete description of the gas-power station of the Charlotte (N. C.) Electric Railway Company, the equipment of which consists of Snow twin-tandem double-acting engines and Loomis-Pettibone down-draft producers for gasifying bituminous coal. At the last meeting of the American Institute of Electrical Engineers, held April 1, at Charlotte, N. C., E. D. Latta, Jr., read a paper in which he presented some operating results obtained in this plant during the past year. The power house contains two main generating units, each a twin-tandem engine of 810 brake horsepower and a 540-kilowatt three-phase alternator. The plant operates 24 hours a day, every day in the year, and the two units operate in parallel during the maximum-load period of each day. The following extract from the engineer's log gives an idea of the degree of reliability with which the machinery operates:

TABLE 1. "TROUBLE" ITEMS FROM ENGINEER'S LOG.

Jan. 1—Exciter spark plug out of order	5 min.
Jan. 31—Exciter trouble	5 min.
Feb.—No trouble.	
Mar.—No trouble.	
April 12—Plant shut down, caused by suction of engine drawing water from the gasometer over into gas main, causing water trap and shutting off gas supply	45 min.
April 27—Same trouble. At the first occurrence it was not known exactly what the source of this water was, and it was attributed to condensation from the gas, but after the second occurrence the trouble was located, and corrected by raising the inner walls of the gasometer, making the lift necessary to draw the water over the top greater than the suction from the engine could accomplish.	30 min.
May—No trouble.	
June 18—Shut down at one o'clock a.m., caused by belt on oil pump breaking; the other engine was undergoing some slight repairs and was not in condition to start	15 min.
July 23—Shut down on account of igniter wire from battery to engine becoming grounded in conduit. This trouble, although located promptly, could not be repaired without great delay; therefore wire had to be run across engine room floor and old wire cut out	45 min.
July 30—Shut down, caused by operation of safety stop on engine, opening igniter circuit	12 min.
Aug.—No trouble.	
Sept.—No trouble.	
Oct.—No trouble.	
Nov.—Shut down, caused by unusual overload occurring when only one engine was in operation	8 min.
Dec.—No trouble.	
Total interruption of service for the year, due to gas and engine troubles.....2 hr.	45 min.

Parallel Operation

While the parallel operation of these engines would not be considered good in comparison with steam turbines operating at high speed with alternators having two or four field-magnet poles, it compares favorably with the best type of reciprocating steam engines with alternators having the same number of magnet poles (60), which, of course, means that the variation in electrical degrees is 30 times as great per degree of angular variation as it would be in a corresponding turbine generator running at 3600 revolutions per minute.

The temperatures of the alternators above room temperatures, so far as can be observed with the constantly varying load, do not indicate excessive synchronizing currents and there has never been any tendency on the part of the synchronous converters to fall out of step. The smaller converter running from one engine or from both in parallel shows no signs of hunting; neither does the 500-kilowatt converter when running from both engines in parallel. It, however, hunts slightly when running on only one engine. This is probably due to the fact that this converter is practically of the same capacity as the one alternator, and the flywheel effect of its rotor is too great to permit its prompt response to the variations of speed, which are greater for a given load with one engine operating alone than when both are in parallel.

There is a slight periodic swing between the pointers of the wattmeters when the engines are operating in parallel; this is, no doubt, accentuated by the extreme sensitiveness of the meters, which have 325-degree scales, and by the pendulum motion of the pointers which is common in instruments of this kind. The same swing appears on the ammeters, but to a much less extent. The engines divide the load very equally, and by adjusting the governors they can be made to divide the load in any proportion that may be desired.

The accompanying engravings show speed records taken with an extremely sensitive graphic recording speed indicator. Each inch of length represents approximately a time interval of 2½ seconds and the spaces between lines represent variations of 1 per cent. Fig. 1 shows the regulation of one unit carrying a load varying between 300 and 500 kilowatts; Fig. 2 shows the regulation of both units in parallel, with a load fluctuating between 900 and 1100 kilowatts, then with 600 kilowatts thrown off abruptly and later thrown on again.

Cost of Operation and Repairs

The figures in Table 2 covering the cost of operation and repairs speak for themselves; the extremely low load factor would doubtless be noticed without calling attention to it. It is due principally to two conditions: First, the prevailing load for twenty hours per day is easily within the range of one unit, but the wide limits of variation make it necessary to operate both engines about ten hours per day; and second, from midnight until 6 a.m. one engine operates on practically no load at all.

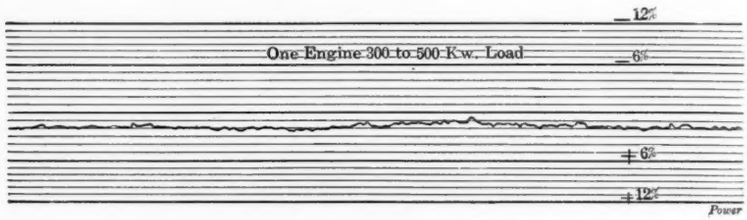


FIG. 1. REGULATION OF ONE UNIT

The items of interest, depreciation, taxes, etc., are not included in Table 2 because they would be quite unfair to the plant, on account of the fact that it was designed for three 810-horsepower units and only two have been installed. The buildings, producers, gas holders, piping, etc., were all installed complete for the full ultimate capacity. Therefore a relatively small additional expenditure for one engine-generator and foundation would increase the capacity of the plant by 50 per cent., while the items of interest, depreciation, etc., would be increased but 18 per cent. per unit of capacity installed.

The owners do not claim high economy for this plant, and can hardly expect it under the circumstances, and while it is hoped that a slight reduction in coal consumption may be effected by a more consistent and economical operation of the producers, a material improvement in operating cost cannot be

expected under the load conditions of the plant.

The largest item in the total cost of repair parts was the cost of an entire new equipment of exhaust valves, which amounts to about half of the total. These exhaust valves were put in, not on account of wear and tear, or breakage of the original ones, but on account of their unsatisfactory design; they continually worked loose from the stems, which were connected by flanges and studbolts. The new type has proved entirely satisfactory.

Four pistons have been taken out and fitted with new rings, the original rings having become broken when water leaks occurred in the cylinders due to defects in the piston castings. Broken rings almost invariably result from water leaks in a cylinder. In this case, new parts were furnished by the manufacturers without charge, and the labor was furnished principally from the operating force.

Considerable annoyance, though only slight expense, has been occasioned by the backing off of the packing glands around the valve stems, caused by vibration, and a consequent breaking of the exhaust-valve casing. This trouble has been corrected by tapping set screws into the packing glands to prevent their working loose.

The least serious trouble that has been encountered, but one of the most annoying, on account of its occurring at most inopportune times, is the breaking of the wedge-adjusting bolts in either the crank or crosshead bearings. About six of these have broken, but the trouble has each time been promptly located, and quickly repaired without further damage resulting.

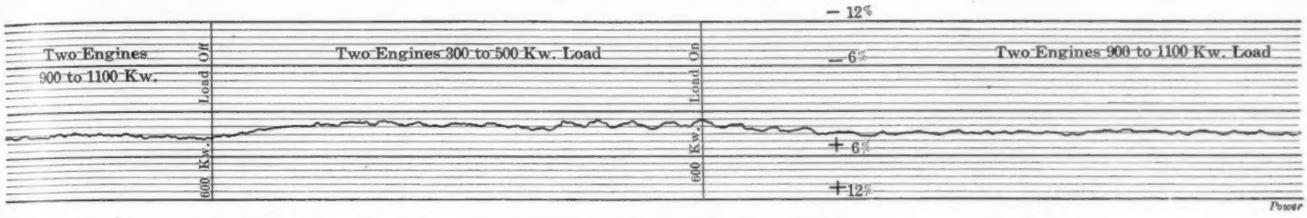


FIG. 2. REGULATION OF BOTH UNITS IN PARALLEL

TABLE 2. OPERATING RECORDS AND COSTS.

	Engine Hours.	Kilowatt-Hours.	Coal.	Coal per Kilowatt-Hour.	Average Engine-Hours.	Load Factor.*
January	1,140	304,400	570,199	1.873	36.8	0.445
February	1,060	278,800	521,190	1.869	37.8	0.438
March	1,019	273,600	531,310	1.942	32.9	0.447
April	1,032	256,607	501,145	1.954	34.4	0.414
May	902	248,400	466,935	1.879	29.1	0.459
June	872	275,300	406,804	1.892	29.0	0.502
July	913	275,100	528,452	1.920	29.5	0.502
August	1,111	284,900	556,959	1.954	36.0	0.427
September	938	276,800	533,844	1.928	31.3	0.492
October	1,102	302,000	585,037	1.939	35.5	0.457
November	1,086	270,700	534,937	1.975	36.2	0.415
December	1,228	327,300	627,469	1.917	39.6	0.430
Totals	12,403	3,355,907	6,444,281	1.92 average	34.0	0.450 average

Coke used in starting producers	260,292 lb.
Coke reclaimed	122,371 lb.
Coke consumed, net	137,921 lb.
Equivalent in coal, as to cost	192,000 lb.
	6,444,281 lb.
Total coal for the year	6,636,281 lb.
Total coal per kilowatt-hour, average	1.98 lb.
Cost of coal per kilowatt-hour	0.349 c.
Cost of power-house labor per kilowatt-hour	0.170 c.
Cost of producer labor per kilowatt-hour	0.131 c.
Oil for power house	0.065 c.
Oil for producer	0.005 c.
Waste and sundries, power house	0.012 c.
Waste and sundries, producer house	0.003 c.
Repair parts for engines	0.046 c.
Repair parts for producers	0.007 c.
Machine-shop work, engines	0.016 c.
Machine-shop work, producers	0.007 c.
Excelsior for producers	0.003 c.
Water, both departments	0.071 c.
Total cost of power at switchboard per kilowatt-hour	0.885 c.
POWER CONSUMED BY AUXILIARIES.	
Cooling water pump, kilowatts per kilowatt-hour	0.0095
Station lighting, kilowatts per kilowatt-hour	0.0116
Motor-driven exciter, kilowatts per kilowatt-hour	0.0688
Total kilowatts per kilowatt-hour	0.0909

$$*\text{Load Factor} = \frac{\text{Output}}{\text{Engine hours} \times \text{capacity of one engine}}$$

PRODUCER OPERATION

In starting a producer the generators are charged to a depth of 5 feet with 72-hour coke, requiring about 6000 pounds to each generator, or a total of 12,000 pounds. The exhauster is then started, and the coke ignited. The gas made during the first 40 minutes is too inferior to be of any use in the engine, and it is therefore blown out through the purge stack.

At intervals of 20 to 30 minutes, up-and-down steam runs are made in the generators in the following manner: The bypass around the exhauster is opened, the charging doors of the generators closed, and steam is admitted for about half a minute beneath the grate bars of one generator, the gate valve of which is closed. This steam passes up through the generator, moistens the ash, breaks up the fuel bed and cools the fuel at the point where clinker is forming, which is not reached by the regular steam supply before decomposition takes place. This special blast of steam leaves the generator through a connection at the top, passing over into the top of the second generator, down through the fuel bed and out through the other apparatus to the holder as a fixed gas. The direction of the steam is reversed on the next run, so that the generators are alternately treated in the same manner. The hot gas leaves the generators at a temperature of about 1200 degrees Centigrade and passes out through a brick-lined nozzle and water-cooled gate valve into the lower compartment of the vertical economizer, which is also brick lined. A large part of the sensible heat of the gas is given off and goes to make steam which is used in the generators and for running the exhauster.

The use of a large holder, such as the one installed in this plant (60,000 cubic feet) is of great value in operation. It takes up the variations in load and allows the producer to be operated at an even rate; also, if the gas varies in quality over short intervals, which is unavoidable, the gases above and below the mean value are thoroughly mixed and a gas of uniform quality is supplied to the engines.

A strip of metal on one of the guides of the holder, and insulated from it, is divided into ten parts, each representing about two feet lift of the holder. Each section is connected to one of ten lamps

arranged vertically on the wall of the producer charging floor. A roller on the lift of the holder makes contact with these strips, and lights a lamp in the producer house corresponding to the hight of the lift. By means of this tell-tale the output of the producers is regulated. If the holder begins to fall, due to a continued heavy demand by the engines, the speed of the exhauster is increased, and the charging of coal is varied accordingly.

It may be of interest to describe here a rather serious difficulty which was encountered in this plant, and the way in which it was remedied.

A short time after the plant was put into operation, it was found that some of the tubes of the economizers were leaking. The tubes were rolled and the leaks stopped, but in a short time they were found to be leaking again. They were again rolled, but continued to leak, and when finally too thin to be any longer rolled they were taken out and replaced with new tubes. The old tubes when taken out were cut into sections and split open, and it was found that they were badly pitted throughout their entire length, although the pitting was worse at the upper end; weighing the tubes disclosed the fact that they had lost nearly 25 per cent. of their original weight. After much surmising, it was decided that the pitting of these tubes was caused as follows:

In the usual design of plants of this kind, with two or more sets of apparatus, the various producer sets are absolutely independent of each other as far as the wet scrubbers, and as the gas is water-sealed in the wet scrubbers it is impossible for gas from one set to pass over into another. In this plant, however, in order to increase the flexibility of operation, the two economizers were connected together at the top by a horizontal header, and each one was cut off from the header by a gate valve. These gate valves, being in contact with gas at fairly high temperature, expand and contract, and cannot be kept perfectly tight during steam runs. When the generators were under pressure, leakage of these valves permitted hot gas to pass from the economizer in operation to the one shut down, and after passing down through this economizer to escape through the open generator. It was found that the economizer not in use sweated profusely on account of the difference in temperature of the room and the water in the economizer, keeping the tubes continually wet. This moisture, combining with the hot gas leaking through the apparatus, undoubtedly formed a strong acid and attacked the tubes. Since arriving at this conclusion, each time a producer is shut down the gates of the valves are thoroughly cleaned, the tubes are cleaned with a wire brush, the tube ends and tube sheet are painted with one coat of graphite paint, and the manholes at top and bottom of the economizers are left open, so that a circulation of air prevents sweating. Since adopting these measures, there have been no more leaky tubes, and it is believed that the trouble has been effectually remedied.

At another time an annoying occurrence was the development of numerous hot spots on the shells of the generators; these hot spots were caused by defects in the linings. The brick of the linings were laid with fireclay-mortar joints, and the space between brick and shell was grouted with fireclay grout. The jarring occasioned by the heavy barring necessary to remove clinker broke the bond of the joints and the grout behind the brick became pulverized and sifted out when the cleaning doors were open. To correct this trouble holes were tapped in the shell, and fireclay grout forced in at various places under about twenty pounds pressure. As the brick of the linings had thoroughly settled when this was done, no further recurrence of the trouble has been experienced. Had the brick been dipped in fireclay grout and laid brick to brick, and the space between the brick and shell been rammed with a mixture of fireclay grout and shredded asbestos, as is the practice with other gas-generating apparatus, the trouble would probably not have occurred.

It is found to be an advantage after cleaning a generator to wash the surface of the brick exposed to the fuel with fireclay grout, as the grout tends to form a cleavage plane between clinker and brick and greatly facilitates its removal. When cleaning the generators, it is not desirable to remove all the clinker, for in doing so a part of the brick would be chipped off each time, and greatly reduce the life of the lining. About one or two inches of clinker adhering to the brick is allowed to remain, and this coating affords great protection to the surface of the lining.

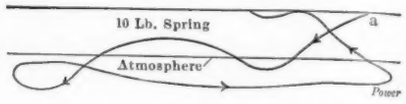
LETTERS

Gas Engine Indicator Diagram

The theory advanced by John S. Leese, on page 491 of the March 15 issue, in which he analyzes his "stop" diagram, is a beautiful one, or would be if it were not based on false premises. Instead of "talking" about a "partial vacuum," his indicator is screaming, "My spring's too weak, my spring's too weak."

To illustrate: If one obtained a helical spring having a great number of coils, made up of comparatively small wire, that is, a long, limber coiled spring, and, after attaching sufficient weight to one end to stretch it to, say, double its free length, then pumped the free end of the spring up and down, the attached weight would perform just as did Mr. Leese's indicator pencil when he was taking the stop diagram.

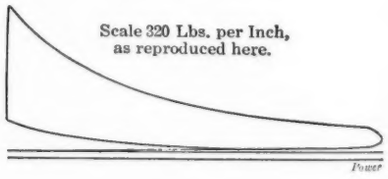
Assuming that for taking a diagram of the working part of the cycle Mr. Leese used a 320-pound spring, as was the case in a test described on page 492 of the same issue, the moving parts of the indicator, if strong enough to withstand the shock of that service, were



MR. LEESE'S STOP DIAGRAM

just 32 times heavier than necessary for use with a 10-pound spring. That is to say, in order to give the indicator a chance to operate correctly with a 10-pound spring the weight of the moving parts should be adapted to that spring.

Going back to my first premise, having to do with the importance of starting out with a cylinder full of mixture, I should like to call the attention of any readers who are interested to the aforementioned gas-engine diagram on page 492, an analysis of which shows that the exhaust valve closed exactly on the inboard center and that the intake valve closed exactly on the outboard center.



AN AVERAGE DIAGRAM

Will Mr. Leese or Mr. Buschman kindly point out any feature that savors of poor practice as shown by the tabulated results of this test?

If Mr. Leese's theory is correct, will he kindly tell us what caused the hump in the compression line just before the merging of this line into the stop line?

E. G. TILDEN.

Downer's Groove, Ill.

[Mr. Tilden has evidently overlooked the explanatory words "as reproduced here," on Mr. Kottcamp's diagram. The spring actually used was 160 pounds per inch, but the size of the diagram was reduced to one-half actual length in reproducing it; hence the spring rating had to be doubled to make the diagram show correct pressures. For similar reasons, Mr. Leese's diagram was marked "10-pound spring;" the spring actually used was an 8-pound one.—EDITOR.]

The production of coal exceeds that of gold and silver; in fact it is nearly double the combined production of all of the metals excepting iron.

FROM READERS *with* SOMETHING TO SAY

PRACTICAL INFORMATION *from the* MAN *on the* JOB: A LETTER GOOD ENOUGH *to* PRINT *is* GOOD ENOUGH *to* PAY *for*

Oil Drain System

During several years of erecting experience I was impressed with the fact that, of the great number of engine rooms which I visited, very few were provided with suitable arrangements for catching the drip oil from the engines. In many cases some attempt to save the oil was made by using a number of pans placed here and there and provided with splash boards and a multiplicity of wings or other attachments projecting from the engine to guide the oil into the pans. In other cases really elaborate and expensive apparatus was used, the most common of which was the familiar sheet-metal trough starting under the end of the guide, running down under the crank and curving around the crank in a half circle.

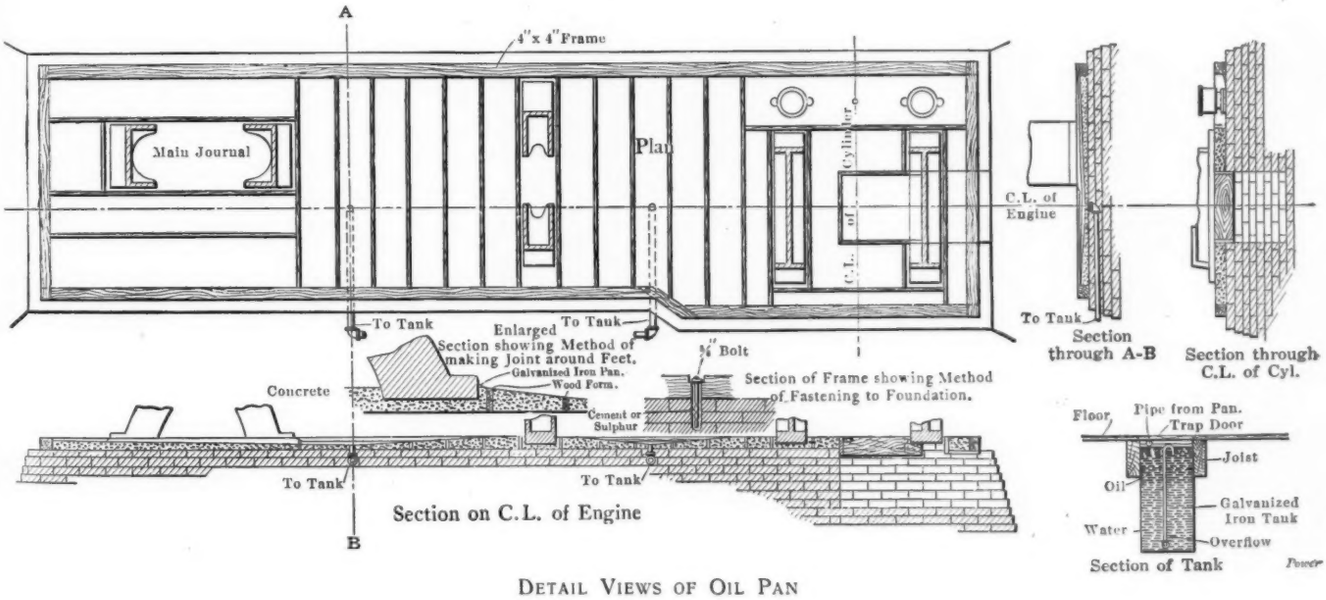
But nearly all of these are only partly effective and come under the head of makeshifts. For one reason they do not catch all of the oil, a large portion of which, flying from the crank and other parts, lodges upon the frame and drips from there into unexpected and unprovided for places. Again, a number of pans half full of oil with pieces of waste, dust and other foreign matter upon its surface detract very much from the general appearance and neatness of an engine room, to say nothing of their wastefulness.

Often no effort at all is made to save the oil and after being taken from the barrel and used on the bearings, it is allowed to fall, for the sake of neatness, on sawdust, cotton-seed hulls or other available material.

Of course the best provision for saving the drip oil of an engine is to have a bed designed for that purpose. But this does not help the engineer who has an engine of the other kind.

It is after placing three of these pans under three Corliss engines and finding them in every way desirable and profitable, that this plan is submitted. An arrangement of this kind not only saves every drop of oil from the bearings, but also takes care of the condensation from the feet of an engine, the method here described may be used to even better advantage. By using a large number of ribs or forms no concrete filling will be necessary.

After removing 2 inches of cement, etc., from the top of the foundation, a rectangular frame of 4x4-inch wood strips was made according to the plan shown and bolted to the foundation. Between these strips were laid ribs of 1x3-inch "cork" pine and toe nailed to the 4x4-inch frame to hold them in position. These ribs were made to slant toward the center drain pipes. After placing the ribs, concrete was tamped between them and filled flush with their tops.



DETAIL VIEWS OF OIL PAN

The piston rod and valve stems. Furthermore, it gives the engineer a clear conscience in feeding oil copiously, thus decreasing the liability of hot journals. Here in the South, where the superintendent is also chief engineer, in factories like cotton-seed oil mills, etc., and must dispense with expert attendence in the engine room, this last point is no small factor.

In case of a hot journal the hose may be turned on and water and oil will go together to the tank, one to overflow and the other to be dipped out or drawn off at leisure and filtered.

The figure herewith shows a pan which was placed under a 24x48-inch engine which is set several inches above the floor and, for that reason, was an unusually difficult and expensive job. In cases where the floor is already built around

The whole surface, including the 4x4-inch frame, was then covered with No. 28 galvanized iron nailed to the forms and soldered at the joints and over the nail heads.

The method of making a joint around the cast-iron pedestals is shown in the enlarged section in the figure. The sheet metal was allowed to lap against the iron at a slight angle and was afterward calked and painted.

A splash board of No. 28 iron on a frame of ¼x1-inch flat iron was erected at the crank end to receive the oil thrown off by the crank.

No figures as to the exact saving effected in this case are obtainable. In one plant two engines were equipped in the above manner, one a 24x48-inch and one a 16x36-inch. The cost of lubricating oil was nearly one cent less per ton

of output over the season previous, or in actual money 95 cents for a day of 24 hours. At this rate we ran long enough to twice pay for the cost of the installation.

HOMER C. FIELDS.

Yazoo City, Miss.

Malicious Tricks

It seems hardly credible that any grown man would indulge in mischievous pranks which he must know might easily lead to disastrous consequences. Yet, in the plant of which I had just taken charge, two tricks of such a nature were perpetrated.

One night, after I had gone home, some noble spirit took out the plug at *A*, Fig. 1, in the base of a Wainwright heater and drove a hole through one of the

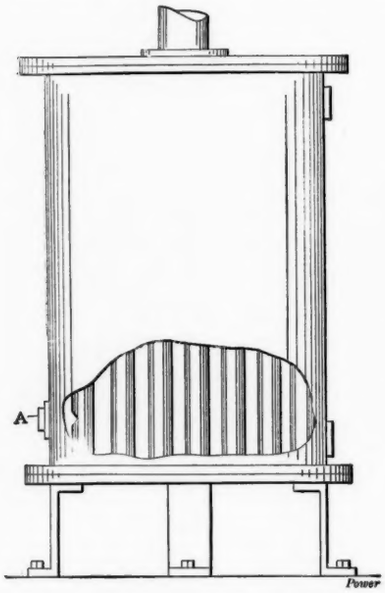


FIG. 1. PIERCED TUBE IN HEATER

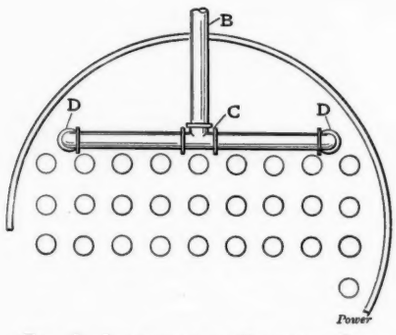


FIG. 2. LOCATION OF PLUGGED TEE

corrugated copper tubes and replaced the plug.

The next day, I was unable to get any water into the boiler but found a stream running out of the exhaust-pipe drip.

Is not this a fine illustration of straightforward manliness?

I was yet to be a victim of a more subtile malice, however. While setting up a tubular boiler, some brave character, while my back was turned, dropped seventeen 20-penny wire spikes, 4 inches long, down the boiler feed pipe *B*, Fig. 2.

FIG. 3. TEE PLUGGED WITH NAILS

The spikes stuck in the 1½x1½x2-inch tee at *C*.

I operated the boiler for three years. Toward the end of that time I began to experience difficulty in getting feed water into the boilers. I tested my pump, inspected all the valves and gave the heater a thorough overhauling, but all to no avail. Things kept getting worse in spite of all I did. It began to look as though I was beaten. I took off the two lengths of feed pipe beyond the ells *D*, and found the portions which extended into the boiler to be quite clean. At last, deciding in desperation to take all the feed line down, I got to work with the hack saw.

Fig. 3 serves to illustrate the complete manner in which the accumulation of sediment on the spikes finally choked up the tee.

If the spikes were dropped into the tee by one who had a full realization of the worry, work and expense his prank occasioned, slow torture would be too good for him.

GEORGE E. WOLSCHENDORF.

East Bridgewater, Mass.

Cleaning a Boiler

There is a right way and a wrong way of loosening scale in a boiler. To which class does this method belong?

An engineer found himself in charge of a boiler which was thickly coated with scale. In many parts the scale was as much as 2 inches thick. He filled the boiler with shavings, and set fire to them. The draft entered through the mud hole at the front end and came out through the manhole on top. The boiler was isolated and in a safe position for the experiment. The scale cracked, broke loose and fell off in cakes, providing a day's work for two men to remove it. The boiler was made as clean as a new one. As may be expected, the coal consumption dropped to a low figure.

H. KENWORTHY.

Manchester, England.

Grading Engineers' Licenses

The three following paragraphs are taken from section 16, of a proposed license law for steam engineers in the State of Illinois, and were drawn up by members of the National Association of Stationary Engineers, and published in the February issue of the *National Engineer*:

To obtain a first-class engineers' license, a man must produce satisfactory proof that he has had ten years' experience in the operation of stationary steam boilers and steam machinery, and by examination must show that his knowledge and experience are such that he is thoroughly qualified and competent to take charge of any type or size of stationary steam boiler, steam engine, or steam apparatus.

A second-class engineers' license will be issued to a man who has had five years' experience (as set forth above), and who by examination shows that he is qualified and competent to be intrusted with the care and operation of stationary steam boilers, engines, etc., not to exceed 100 horsepower.

A third-class engineers' license will be issued to a man who has had two years' experience (as set forth above), and who by examination shows that he is sufficiently acquainted with the duties of an engineer to be intrusted with the care and operation of stationary steam machinery, not to exceed 20 horsepower.

A man licensed as first-class, ought to be a better engineer than a man licensed as third-class; but in Ohio the reverse

is very often the case, and the engineers are at a disadvantage for lack of just such terms in the law as the above. For instance: If you take a trip to several of the factories and ask for employment, stating that you have a first-class license, you will in the majority of cases be told, "We do not go by the license; we have had men who only had a third-class license, but who gave us better service than others we have had with first-class licenses."

I recall the case of two men who work in the same mill. One might be called an engine runner and possesses merely the knowledge necessary to stop and start an engine and to oil the bearings; yet he has a first-class license. The other man is just as good an operator as the first, and in addition is able to set valves, figure capacities and read diagrams intelligently, but has been able to obtain only a second-class license.

The cause of this condition in Ohio dates back to when the city license laws first went into effect. A license could then be obtained by having some engineers sign an affidavit stating that they knew the applicant to be competent, reliable, etc., and in some cases the applicant himself did not even see the examiner. Later on, a State license law was substituted, granting only one grade of license, that of first class. As these city licenses expired they were renewed, or perhaps better stated, "exchanged" by the State examiner for a first-class State license. Next (by what now appears to have been simply an order from the chief examiner), the department issued first-, second- and third-class licenses, according to the amount of experience and knowledge a man had as shown by his examination. Last April, all licenses issued before May, 1902, whether by renewal or otherwise, were canceled and the holders had to be reexamined at once, because the law as it stood prior to May, 1902, had been declared unconstitutional.

It was hoped that thereafter every man's license would be an evidence of his actual ability. I am sorry to state that such was not the result. The old licenses in most cases were exchanged for new ones of the same grade, and only in a few cases was the grade lowered. The men were examined orally and one man told me himself that from the time he entered the examiner's office, was examined after waiting his turn, told his percentage, given his new license and out on the street again, only 30 minutes elapsed.

It has always been my idea that all experience or all education should never fit a man to obtain a first-class license. The requirements outlined at the beginning of this letter would tend to raise the standard of a first-class license, and by this plan, no matter how well educated a man might be, he could not *walk over* the older heads; on the other hand, a man with 40 years' experience could not get a first-class license unless he studied and acquired the necessary education.

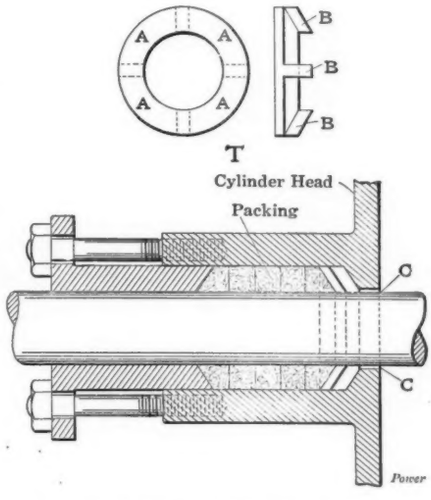
In justice to the Ohio law as it is applied now, I must state that to get a first-class license an applicant now has to meet the conditions as outlined herewith. But the fact remains that this host of old license holders are still holding the best-grade licenses and that they have never faced the test.

HARRY W. BENTON.

Cleveland, O.

A Compensating Gland

The figure shows a device intended to remedy the evils of a leaky stuffing box and may be referred to as a compensating gland. It is composed of an iron casting *T*. The gland may be made to fit any size pump or steam engine. The four projections marked *B* serve to keep the gland up off the stuffing-box seat; *A* is the space between the projections *B* when the gland is in position. The steam or water flows through the clearance space *C*, filling the space *A* and forcing the packing upward or outward and tight against the rod. When the pressure in the cylinder becomes less, the pressure



GLAND AND PACKING IN POSITION

on the gland also relaxes, and by giving the gland more or less taper any desired pressure can be obtained. By drawing the under side of the upper gland shoulder down against the side of the stuffing box the two long studs would be unnecessary, and a shorter upper gland could be used. This would make a much nicer appearance than the old-style stuffing box in which the pressure is the same regardless of the pressure in the cylinders. I have never seen this idea worked out but it looks practical.

D. M. LE FEVER.

Rochester, N. Y.

Engine Knocks

During the summer of 1908 I erected a 22x50-inch Wheelock engine which had just been overhauled by the builders. Part of their work had consisted in putting a new bushing in the bottom of the stuffing box. This bushing projected so far into the cylinder that it was almost impossible to adjust the piston travel so as to avoid striking the cylinder head at one end or the bushing at the other.

At the first opportunity, the bushing was removed and somewhat shortened. Still there was a thump in the engine which seemed almost impossible to locate. Thinking that it might be due to unequal clearance, I took some more off the bushing and adjusted the clearance. This time the knock disappeared.

In another instance a small Ideal engine had a habit of knocking and running hot at the crank pin. The only thing that appeared to be wrong with it was a hole in the babbitt in the crank box. This I filled with solder and the trouble disappeared. I never have been able to understand how that little hole could cause so much trouble.

R. MCLAREN.

Berlin, Ont.

Installing Globe Valves

In the plant in which I am employed there is considerable piping, ranging in size from 2½ inches down to ⅜ inch. Globe valves with composition disks are used and many of these are on lines on which 80 pounds of steam is carried. It is necessary to cut out certain sections at times and considerable trouble has been experienced with leaky valves. They had been installed with the pressure on the under side of disks; a practice in vogue some years ago but which has of late been subject to criticism. Steam is shut off at the boilers each night and the piping drained. These drain valves gave considerable trouble, and it was impossible to keep them tight for any length of time. New disks were put in but gave only temporary relief. As a result, it became the custom to close these valves down as hard as possible, which had a tendency to strip threads on the stem.

It being my duty to look after the two main valves, I determined to put my ideas into practice and accordingly hunted up an old composition disk valve, put in a new disk and connected it up, with the pressure on top of the disk when the valve was closed. This ended my troubles in that direction.

I believe that all valves, except those used as throttles, should be installed with the pressure on top of the disk when closed, for the following reasons: The disk will last much longer, threads on the stem do not wear so fast, and the valve will remain tight much longer, as

pressure tends to force the disk against the seat. One objection to connecting valves in this way is that the pressure cannot be throttled so closely as with the pressure under the disk, on account of lost motion in the stem threads and between the disk holder and stem. This can be partly overcome by inserting shims between the disk holder and the end of the stem. If large valves are installed this way there should be a by-pass to equalize the pressure before the main valve is opened.

C. C. HARRIS.

Springfield, Mass.

Filling a Lubricator

The following idea, although simple, has proved to be a good one and may possibly be new to some fellow engineer. In filling a lubricator, on opening the drain cock and removing the filling plug, as the water starts to run, begin at once to pour in the oil. The water, being thinner than the oil, tends to flow more rapidly, thus producing a partial vacuum which hastens the flow of the oil. By the time the lubricator is empty of water it is about full of oil.

This is a time saver, especially if the oil happens to be a little cool.

S. C. GURNEE.

Weedsport, N. Y.

Blowing Mud from Boilers

The large amount of mud so often found in boilers on opening them for washing has often led me to doubt that much good is accomplished by the usual process of blowing down, or at least to wonder if a more effective scheme could not be devised.

Recently the following scheme came to my mind, which seems so simple that it must have been thought of before; so I would like to submit it to the readers of POWER for criticism as to its worth. The scheme is as follows:

Place a pipe in the bottom of the boiler the size of the blowoff and connected to it. Close both ends of this pipe and have a row of holes in its under side for its whole length; support the pipe about an inch above the shell. With such a device, in blowing down, the muddy water would be drawn from the whole length of the boiler and the bottom would be washed clean. By properly spacing the holes the water could be taken uniformly from the entire length of the boiler or a greater part from directly over the fire as found to be best. In cases where the boilers stand part of the time with banked fires the blowing down should be done just before starting the fires as then the mud would have settled to the bottom and could be thoroughly removed. In cases where the boilers operate continuously a time should be chosen when the load is light, the fires low and the circulation in the boiler as quiet as possible.

I recognize that the above plan would not remove as much loose scale as the open blowoff arrangement, but the scale that would be left would not do as much harm as the mud that is left by the usual method.

G. E. MILES.

Denver, Colo.

Rules for the Engine Room

The following is a set of rules for the engine room which were given to me a few weeks ago, by a salesman. I think they are pretty good and I have met with visitors in my engine room whom I would gladly refer to them:

When you enter the engine room, spit on the floor. We have water, lye, soap, mops and brushes, and will clean up as soon as you leave.

Rub your hand on all polished work. It will give someone work, and use the surplus polish.

Put your hand on the engine's bright parts. You will then know if they are smooth, hot or cold. Tell others to do the same.

Stay in the engine room as long as you please. The engineer has nothing to do but entertain visitors.

Be sure to tell the engineer if his engine is pounding or running right, as he will not know unless you do. He will stop and make repairs while you wait.

Don't tell the engineer who you are. He is a mind reader and already knows you. Go anywhere in the engine room and you will please him.

Advise him what to do, as you know best. The engineer is there only every day and does not have a chance to see as much as you will in an hour.

If the engineer is busy making repairs, tell him a good story, and, if possible, get in his way.

Be sure to tell all you know. It will not take long.

Call again and repeat as above.

Clean your feet when going out.

J. H. HIEBER.

Spokane, Wash.

Improving a Damper Regulator

The boilers of a large apartment house were equipped with the old-style, direct-connected damper regulator as shown in the lower part of Fig. 1. It gave such un-

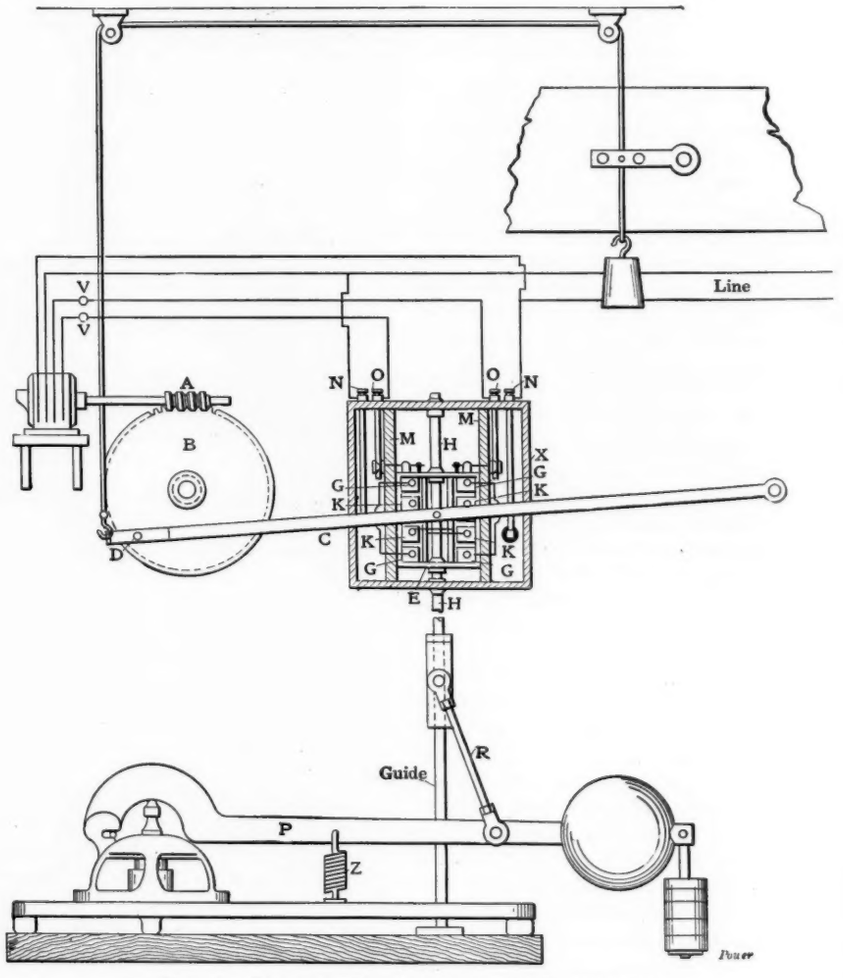


FIG. 1. GENERAL ARRANGEMENT OF REGULATOR

satisfactory service that the engineer disconnected it, preferring to use the hand dampers. When the present engineer

took charge, he determined to make that damper regulator useful, and considering the limited material at his disposal he succeeded very well. Never having seen a regulator work on similar principles and therefore believing it to be new, I shall endeavor to briefly describe it.

Having a small direct-current motor on hand, the engineer coupled thereto the worm shown at *A* in Fig. 1, the function of which is to turn slowly the spur gear *B*. The lever *C* is loosely attached to this gear by the pin *D*, and in the same manner it is also attached to the oblong box *E* by the pin shown. Loosely attached to each corner of the box *E*, which is shown in greater detail in Fig. 2, are the carbons *G*, the two lower ones having small coil springs fitted around the holding screws to insure a slight give. Rigidly attached to the upright spindle *H* are four other small carbons *K*, the two contiguous ones being separated by the fiber board *L*. These four carbons are free to move inside the box *E*, while the box itself is also free to move between the guides *M*. From the upper side of the containing box *X*, which serves as a casing, drop the bus rods *N*, *N*, *O*, *O*, on which bear small spring-pressed, contact rollers. The electrical connection between the line, carbons and motor can be easily traced and are such that when the regulating lever *P*, Fig. 1, rises, spindle *H*, being connected to it by the link *R*, will cause the upper carbons *K*, Fig. 2, to make contact with the upper carbons *G*. Thus a circuit is formed which starts the motor in the direction necessary to close the damper. But as the lever *C* is connected to both the gear and the box *E*, it is obvious that the motor can make but a few revolutions before the circuit is again opened by the upper carbons *G* being moved away from the carbons *K*, and it becomes necessary for the steam to again slightly raise the lever *P* before the circuit is restored. By following the manner of wiring, it will be apparent that whenever the steam pressure drops and lever *P* lowers so that the lower carbons *K* make contact with lower carbons *G*, the motor will reverse, and the damper will gradually open. The switch is in the armature circuit, and *V*, *V* are resistances.

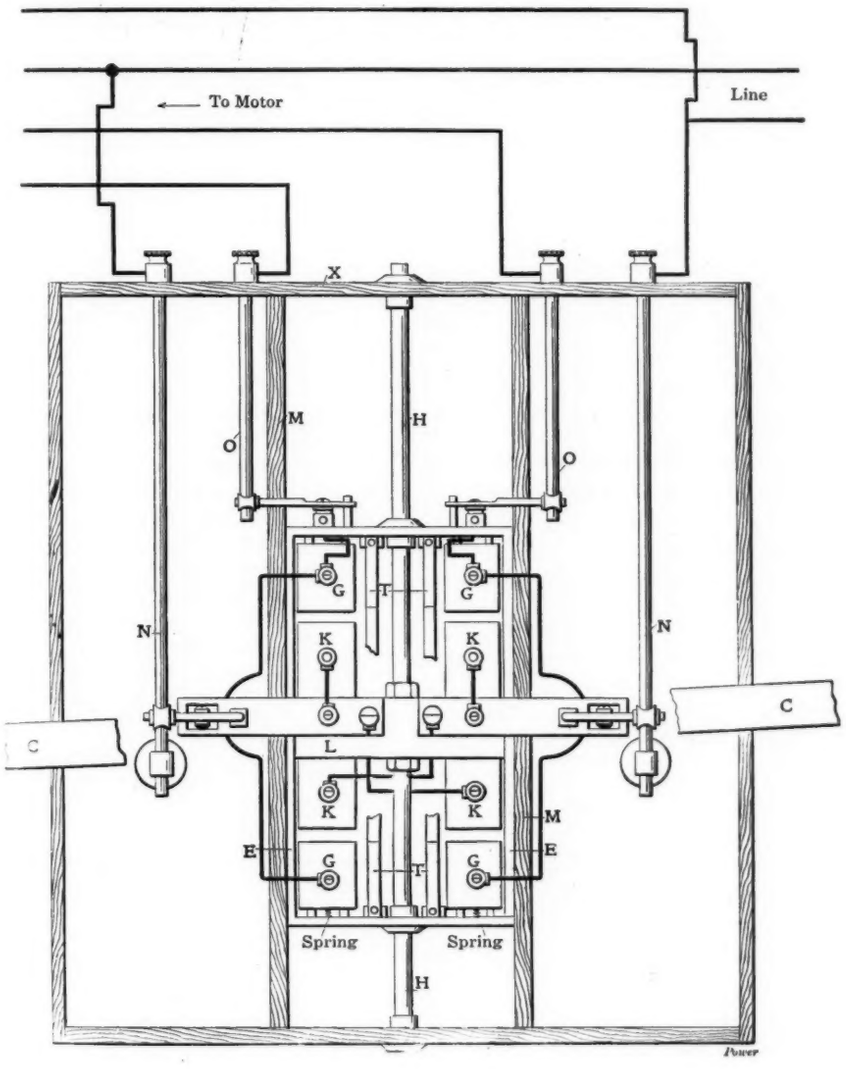


FIG. 2. DETAILS OF WIRING

R. O. RICHARDS.

Framingham, Mass.

Trouble with Boiler Safety Plugs

I had been having a lot of trouble with a leaky fusible boiler plug. This plug was removed and another one put in. This one held good for a week or so and then began to leak. The leakage increased until in a few days it got worse than the former one. It was so bad that it kept the fuel at the back of the fire wet, and at night, when the fire was banked, it would put the fire out altogether. I reported the matter to the manager and he prescribed this remedy. Two iron plates were cast 5 inches square. One side of one plate was made concave to fit the water side of the furnace crown and one side of the other plate was made convex to fit the fire side. A sheet of asbestos ⅛ inch thick was to be put between patch and furnace crown on the fire side and a mixture of white and red lead on the water side. I did not at all like such a patch and objected to it, so they sent for the boilermaker. He explained that it would cause the furnace crown to crack. The water would be held off 25 square inches of the furnace crown, and also protected from the fire on the other side. The boilermaker's remedy was to heat a small wrought-iron plate, which he picked out of some scrap, to nearly a white heat and lay it over the hole. This was meant to heat the crown of the furnace just at the hole. From the edge of the hole to about 3 inches all round, the plate was hammered to make it shrink and then a new plug was fitted in. This gave me no trouble for a month but then began a little persistent fizzling. I thought that maybe the plug had been put in cross-threaded, so at next boiler cleaning it would have to come out and be put in properly. With a nicely fitting spanner and 4 to 5 feet of leverage it could not be made to budge.

What was I to do? I thought of metallic cement. The iron dressers use it to trim up defective castings. I took some of this and made a paste and plastered it around the plug, trying to work it into the thread as well as I could. When this dried I covered it with white lead, having the idea that it would keep the water off the cement so much the longer. I repeated this operation at three or four subsequent opportunities. I believe the trouble is permanently cured.

H. KENWORTHY.

Manchester, England.

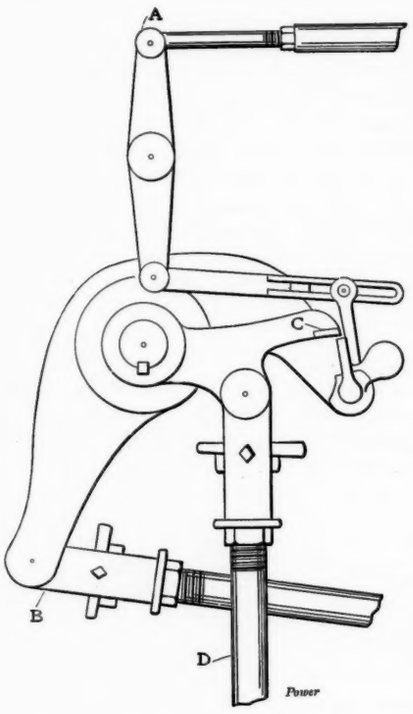
SUBJECTS *under* DISCUSSION

COMMENT, CRITICISM, *and* DEBATE *upon various* ARTICLES, LETTERS *and* EDITORIALS *which have* APPEARED *in* PREVIOUS ISSUES

Damaged Trip Mechanism

In the issue of February 8, A. W. Griswold relates an incident wherein a hook bolt on a 20 and 36 by 42-inch cross-compound Corliss engine broke and although the receiver pressure ran up to 55 pounds the cylinder-relief valves did not open, which endangered the safety of the low-pressure cylinder.

In the figure is shown the George H. Corliss trip motion which was on an engine with which I had a similar experience, the only difference being that in my case the hook bolts became loose and



GEORGE H. CORLISS TRIP MOTION

the latch steel *C* broke right across the bolt holes and a piece fell into the dashpot and in some way caught, which caused the dashpot rod *D* to be bent, thereby preventing the steam valve from closing.

After stopping the engine we disconnected the bent dashpot rod, which released the steam valve, permitting it to close, and then we took the wristplate connection *B* off entirely.

At the opposite end of the cylinder we disconnected the governor rod *A*, thereby allowing the steam at that end to follow the piston as far as possible.

The whole change was made in a few minutes and everything went right along without further adjustment.

We let the exhaust valve on the disabled end of the cylinder run as usual so that any steam leaking by the steam valve or piston was released in the same way as though both steam valves were in operation.

Not having a spare latch steel on hand, the engine ran in this condition until one was made at a local machine shop. Although the engine was furnishing power to drive some 900 cotton looms I did not hear any complaints about uneven speed.

If the dashpot rod *D* had remained straight and nothing else had interfered to prevent the steam valve from remaining closed, we could have simply slipped the studs from the ends of the connection *A* without stopping the engine.

The failure of the cylinder-relief valves to work was caused by their being set up too tight. A good way to remedy this while the engine is running is to slacken the springs until the steam blows by the valves, then tighten them again until they close and then give the nut or crank, as the case may be, one-half turn more.

J. W. PARKER.

Clinton, Mass.

Newton's Law Suspended?

The ball is held suspended in mid air in front of the blower when the air issues at an angle because the air just coming from the blower is under a pressure lower than that of the surrounding air. The action is in reality equivalent to sucking the ball toward a place of reduced pressure. But it may be argued that the ball is supported some 12 inches away from the outlet and is not sucked up to it as should be expected if the pressure is less there. This is accounted for by the fact that the force of impact is acting against the side of the ball opposite to that upon which the atmospheric pressure acts. Therefore, the ball will assume a position at such a distance from the blower that the force of impact of the air plus the low air pressure on the one side is just equal to the atmospheric pressure on the other side. There is present a third force, gravity, acting downward upon the ball so that it is held in a position somewhere below the center of the air jet, where the three forces are in equilibrium.

A piece of cardboard placed behind the ball, on the side away from the blower, and moved toward the nozzle will cause the ball to move along just about 2 inches in front of it. This is explained by the fact that the air jet which passes by the ball and strikes the card is deflected and reacts upon the ball and surrounding air so as to increase the back pressure on the ball. As the card and ball are moved

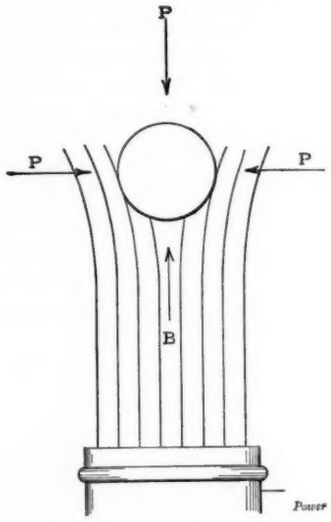


FIG. 1

toward the blower the impact on the front of the ball will be greater and then again, for the same reason, the back pressure will be increased and so the relation between the two is kept constant and the ball will always remain at a certain distance from the card.

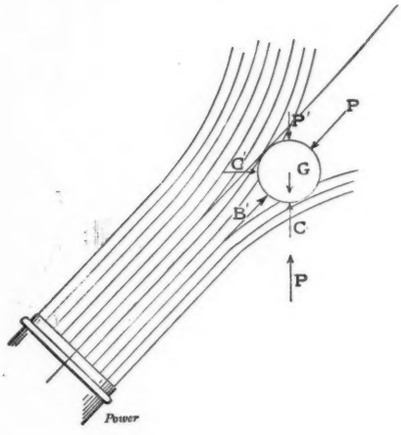


FIG. 2

The holding of a small object in front of the ball produces the same effect as the card held in back of it as far as the motion of the ball is concerned. It does this by diminishing the force due to impact on the front side of the ball while

the card increased the pressure on the opposing side. The reason why the small object is capable of reducing the impact force is because it intercepts and absorbs the kinetic energy of a part of the air jet which, otherwise, would have struck the ball.

It remains to be explained why the ball is supported at the same level when the air jet is projected at an angle as when the jet is vertical. I shall not try to prove that such should be the case because it would require considerable mathematics. But I shall try to show that the conditions are such that it is not an impossibility. At first thought it appears to be a contradiction of nature when the ball is held up just as high when the blower is off to one side and not directly under it.

When the ball was supported by the blower in a vertical position the forces acting upon the ball are represented in Fig. 1. The downward forces are the force due to the pull of gravity, and P, the pressure of the atmosphere. These are opposed by B, the force of the impact of the moving air. It is evident that the air current is deflected to the sides, as shown by the lines, so that the pressure on the upper side of the ball is that of the atmosphere. The ball is kept from moving sideways because the pressure in the moving air jet is lower than the surrounding air pressure P, and, therefore, it will be pushed back by P whenever it rides off to one side.

Now let us turn to the inclined-jet action. The vertical forces acting upon the ball in this case are shown in Fig. 2.

Again G is the force of gravity and P is the normal air pressure acting upon the side of the ball remote from the nozzle and also acting vertically below the ball. The force B', due to impact of the air, strikes the ball at an angle. Applying what our mechanics teaches us, namely, that a force acting upon a body at any angle may for the sake of simplicity be resolved into two other forces (components) along two perpendicular lines by projecting it upon these lines, we will resolve B' into the force C acting upward and the force C' acting horizontally. It is plain that force C in Fig. 2 is less than the force B in Fig. 1 and so it would seem as though the ball could scarcely be supported in this position. But upon further consideration, it will be noticed that the air path above the ball is nearly vertical and so the pressure P' above the ball will be quite low. Then, since the lower surface of the ball is exposed to the impact of the jet and also to a pressure P very nearly equal to that of the atmosphere, because the lower face of the ball is nearly out of the path of the jet, we see that there is a total upward pressure equal to $P+C$. The pressure P' being small, there will be sufficient force to hold up the weight G. I have not proved that the ball will stay at exactly the same level whatever the angle of the outlet, but I have tried to show that with the blower at a greater distance and the jet at an angle, so that the impact forces are less than in the case with the blower vertical, the conditions are such that it is not at all impossible that the ball should easily be supported at a level just as high because the pressure acting on the upper side of the ball will be diminished enough to make up for the loss of force on the lower surface.

The article in POWER about this blower did not state that the ball could be supported with the jet acting vertically downward. I think that it could, providing my reasoning is correct.

JAMES L. HAYNES.

Brooklyn, N. Y.

In the February 22 number, an interesting experiment is described in which a light rubber ball is kept suspended in space by a blast of air issuing from a blower at an angle of 45 degrees. At first glance this would seem to be contrary to the law of gravitation, unless one is familiar with the laws governing air pressures on spherical surfaces.

If any spherical object is placed in a current of air whose direction is opposite to the force of gravity, the sphere will be kept in space if the upward pressure of the air on the sphere is greater than the force of gravity. The sphere will assume a position exactly in the center of the air stream, and, if in any way it is displaced from the center the distribution of air pressure will be such that an increase of pressure will result on the side farthest from the center, which will bring the ball back into the central position, where it will be in equilibrium. In the case of the rubber ball described in the experiment where the direction of the air stream is at angle of 45 degrees to the direction of gravity, this law just mentioned is the cause of the ball remaining in the air current and not dropping, as one would naturally think. When the ball is first placed in the air current the tendency of the air flowing past the ball is to bring it to the center of the air stream, but there is the constant force of gravity tending to pull it away from the center of the air stream. As the ball is pulled away from the central position, the pressure tending to bring it back to the center increases until the force of gravity is just balanced by this air thrust, at which point the ball will remain. It will be noted that, in all the experiments described, the rubber ball always remained at the lower edge of the stream, just where we would naturally expect it to be after an equilibrium had been established by the force of gravity and the unbalanced air pressure.

JOHN FRENCH.

Washington, D. C.

Under the above title appeared an article in the issue of February 22, concerning the peculiar behavior of a ball acted upon by a jet of air. This apparently law-defying phenomenon is dependent upon the fact that in a region of high velocity there is a correspondingly low pressure.

In a stream of moving fluid the pressure is always greatest in the wide portions of the stream where the velocity is least, and least in the narrow portions where the velocity is greatest. Consider the pipe $A\,B$, Fig. 1. Assume that a stream of air is flowing through the pipe. It is evident that the quantity of air which passes through the narrow part

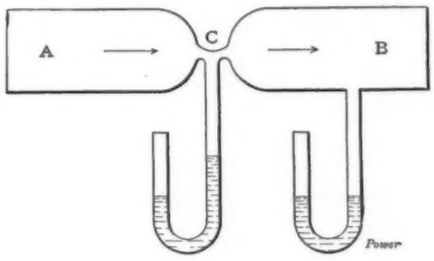


FIG. 1

C, per unit of time, must be equal to the quantity which passes through the wide part A. If this were not the case, air would accumulate in larger and larger quantities between the points C and A. If the quantity which passes through the part C is the same as that which passes through A and B, it is evident that it will have to move with greater velocity through the part C than through the wider parts A and B. Consequently, C is a region of high velocity in the moving stream and A and B are regions of low velocity. Therefore the kinetic energy of the moving stream is greater at C than at A or B.

Evidently as the air moves from A to C it is accelerated by an excess of pressure at A over that at C. As it passes from C to B it is retarded by the higher pressure at B. That is, the kinetic energy possessed at C is used up in overcoming a higher pressure at B.

That the pressure at C is less than at B may be demonstrated by attaching U-tubes. It will be found that the liquid in the tube at C will stand at different levels as shown, thus proving that the pressure at C is less than that of the atmosphere, while at B the liquid will stand at practically the same level in both legs of the tube, B being open to the atmosphere. The U-tube might be attached at A instead of at B, and we would have the same result since A and B are the same size and carrying the same quantity of air.

Now consider the arrangement shown in Fig. 2: D is a nozzle from which a stream of air is escaping at a high velocity; E is a light ball which is in contact with the jet as shown. Under these

conditions the forces acting on the ball are in equilibrium, and it will remain at rest. An analysis shows that there are three forces acting upon the ball. First, force *G*, due to the weight of the ball and acting downward. Second, force *P*, the pressure of the stream against the ball due to impact. Third, force *R*, the unbalanced portion of the atmospheric pressure, acting from the right. This force arises from the diminution of pressure on the left side of the ball, due to the velocity of the stream in that vicinity. It will readily be understood that these three forces may be in equilibrium, their relative values being represented by the sides of the vector triangle *T*.

Any change in these forces will cause an unbalanced condition, and the ball will move to a position where equilibrium exists. The force of the jet is dissipated

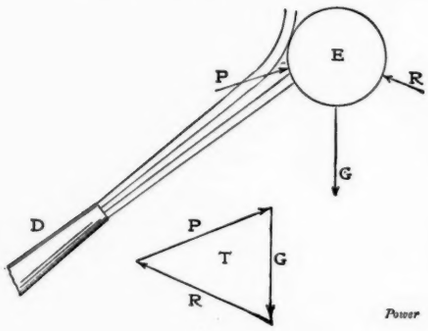


FIG. 2

in the surrounding air; consequently the farther away from the nozzle the weaker the force *P* becomes. Interposing an object and partly covering the jet weakens it and the ball will move toward the nozzle until a point is reached where the force *P* is sufficiently great to preserve equilibrium.

From these brief considerations we may conclude that the ball is acting in the only way in which it could reasonably be expected to act, and that Newton's law has not been violated.

A. R. SQUYER.

Ames, Ia.

Over-loaded Engine

In the issue of February 15, W. C. Schueler describes a trouble he has with an overloaded cross-compound Corliss engine. I judge that he has not applied an indicator to his engine; a set of diagrams would have helped us to give him direct advice. He should have his engine indicated.

It is my opinion that there is a very bad leak through the high-pressure cylinder into the receiver; perhaps the piston is leaking and the excessive quantity of steam getting into the receiver is due to this leak and is not the result of exhaust steam from the high-pressure cylinder. Therefore, the high-pressure cylinder is only developing a small amount of the power it is capable of developing. Leakage would account for this loss of power, and also for the abundant supply of steam in the receiver.

It will thus be seen that the low-pressure cylinder must develop an extra amount of power, because the high pressure is out of order, and that it is able to do so because the supply of steam in the receiver is abundant to allow such a late point to cutoff.

If Mr. Schueler will thoroughly inspect his engine, internally, and go over the valve gear to see that all of the valves are correctly adjusted, I believe he will find the cause of his trouble and I also think that when he gets the trouble corrected, the engine will carry the load without difficulty.

HARRY W. BENTON.

Cleveland, O.

Cylinder Lubrication

We have an 18 by 36-inch Corliss engine running at 100 revolutions per minute, noncondensing. The steam pressure is 90 pounds. We use two drops of Capitol cylinder oil per minute.

In an 11 by 22-inch, four-valve engine, running 150 revolutions per minute, we use one drop of the same kind of oil per minute.

In a 12 by 14-inch vertical ice-machine engine we use one drop every two minutes.

D. M. GRONE.

Covington, Va.

We have one 20 and 42 by 42-inch cross-compound Corliss engine running condensing at a speed of 100 revolutions per minute. The steam pressure is 125 pounds. In the high-pressure cylinder we use one quart of oil per 24 hours, which costs 49 cents per gallon. In the low-pressure cylinder we use one quart of Magnolia cylinder oil per 24 hours, which costs 30 cents per gallon.

We have also an 18 and 36 by 42-inch cross-compound Corliss engine driving a two-stage air compressor. The speed is 30 revolutions per minute. In this engine we use two quarts of the 49-cent oil per 24 hours. We cannot make this engine operate satisfactorily on less oil. This is probably due to the low speed at which it is operated, which makes the valves very hard to lubricate.

J. H. MORE.

Milwaukee, Wis.

After examining the table in the February 15 number of POWER, showing cylinder-lubrication practice, we have tabulated in a similar manner the results obtained in the operation of our cross-compound Buckeye engines.

We have been using the same kind of cylinder oil (600W) in both high- and low-pressure cylinders. About one-half the quantity used in the high-pressure is required in the low-pressure.

We are now experimenting with the use of a still smaller quantity of oil in the low-pressure cylinder, and are led to believe that we can continue the use of 600W oil for the low-pressure in this way, so that the actual cost of lubrication will be no greater than if we used a lighter, cheaper oil.

The results given below, though not the best, seem to compare favorably with the table mentioned.

Cross-compound Buckeye engines: Horsepower at normal load, 700; diameter of cylinders, high-pressure, 24 inches; low pressure, 42 inches; stroke, 36 inches; revolutions per minute, 100; boiler pressure, 135 pounds.

Square feet of surface rubbed over per hour: High-pressure, 225,600; low-pressure, 396,000; kind of oil used, 600W; pints per hour, high-pressure, 0.133; low-pressure, 0.067.

C. D. ELDREDGE.

Fairport Harbor, O.

Vertical Engine Bearings

I wish to make a correction to my letter on the above subject which was published in the March 8 issue. In the last sentence there is the statement, "vertical-engine shaft bearings should be kept 'swung' just as carefully as those of horizontal engines."

This statement should have been, "vertical-engine shaft bearings should be kept 'snug' just as carefully as those of horizontal engines."

HARRY W. BENTON.

Cleveland, O.

Engine Cylinder Cannot Act as Pump

In the issue of February 8, Mr. Hudson says that an engine cylinder can act as a pump. I judge by reading his article that he refers to a compound engine running noncondensing. In such a case there could not possibly be any pumping action by the low-pressure piston. He must remember that after the steam is shut off, and the steam valves closed, there is just as much air or vapor on one side of the piston as on the other. While the piston is making one stroke with the exhaust valve closed and producing a vacuum in the portion of the cylinder back of the piston, the air or vapor in front of the piston is being pushed out of the cylinder through its open exhaust valve into the exhaust passage where it is ready to reënter the cylinder the instant the other exhaust valve is opened, thus satisfying the vacuum produced on the other side of the piston. This practically constant volume of air or vapor is simply being exchanged from one end of the cylinder to the other through the medium of the exhaust valves. There exists during the different portions of the stroke a variation of pressure in the cylinder, but as there is

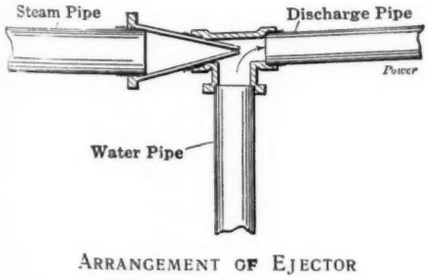
no displacement, there is no pumping action. The only way that water could be drawn into the cylinder would be by means of a faulty construction of the exhaust passage. If sufficient water is trapped in the exhaust, as the vapor in the cylinder condensed, air rushing in through the exhaust pipe would carry the entrapped water with it. This is directly the result of condensation and not of any pumping action of the piston. As to the water getting in, the result would be the same when the engine was standing, if the cylinder were filled with steam and then the steam valves were closed. The vapor would condense and the vacuum thus formed, would have to be satisfied by the exhaust valves taking in air from the exhaust pipe and any water which might be present.

C. M. HUXFORD.

Thomaston, Conn.

Homemade Ejector

I noticed W. O. Regan's ejector in the January 25 issue, and I think I have one which is simpler and will do the same work that his will do. The company for which I am now working has a wheel pit 8 feet deep, which in wet weather gathers a large amount of water. Three years ago when I went to work for them, they had a bucket tied to a stick, with which the pit was bailed out. It took a man from three-quarters to one hour two or three times a week to keep the pit clean. I made an ejector according to the figure herewith, which takes the water out in from three to five minutes. It is made of a ½-inch tee and a common nozzle, which I took from a piece



ARRANGEMENT OF EJECTOR

of 1-inch, rubber, sprinkler hose. The nozzle was threaded on the outside with a ½-inch pipe die, and screwed into the tee as shown. Into the large end of the nozzle the steam pipe was connected, and in the steam pipe was inserted a valve for controlling the pressure, the other two tee connections having the suction and the discharge pipes. I think this is as simple an ejector as could be made. It is required to make an 8-foot lift, but I think it would lift twice that hight equally as well.

D. M. GROVE.

Covington, Va.

A Broken Piston Rod

The letter of Mr. Williams in the February 15 issue, dealing with duplex-pump troubles, reminds me of an experience I had several years ago. I was steamboating at the time, and we were obliged to lie over on Sundays at a small country town in Maryland, the sole manufacturing establishment of which was a paper mill. One Sunday afternoon the superintendent of the mill drove down to the boat and asked to see the engineer. I informed him that I was the engineer and he told me that they had some trouble with their pump up at the mill and had been working on it since early the night before without being able to get the pump to work. He asked me if I would ride up to the mill with him, and see if I could find what the trouble was. I consented, and on the way up questioned him as to what had been done to solve the difficulty. His replies satisfied me that all the usual means had been resorted to and in addition a number of unnecessary things.

Upon arriving at the mill, I found the pump to be single acting with about a 12-inch water end, and having a solid plunger. I looked into the water cylinder to see what kind of a fit the plunger made and found it to be sufficiently tight and showing very little signs of wear. Then I happened to glance at the crosshead and noticed it was back at the steam-cylinder end while the water plunger was out at the open end of the water cylinder. I remarked to the superintendent that the piston rod was broken, and pointed out the position of the crosshead and plunger. Of course, they all saw it at once, and it was amusing to hear the superintendent revile everybody, including himself, for not noticing the break after having worked on the pump for about 18 hours. He was very anxious to have the mill running Monday morning, and asked what could be done. I replied that the only thing to be done was to get a new rod. It was impossible to get one from the makers under several days and I suggested that he get a piece of shafting and have the local machine shop turn it; but upon investigation we found that they had only one small lathe and had no facilities for cutting a thread. So when I left, it was decided that the best thing he could do was to take the train to Baltimore the next morning and have a new rod made.

The next morning, at seven o'clock, I was surprised to hear the mill whistle blow and noticed that the mill seemed to be running as usual. I took a walk up to the mill to see what they had done, and found the old pump running as good as ever. I inquired of the engineer as to where he had gotten his rod, and he replied that he had found a length of shafting just the right size, but that the machine-shop man would not open his shop to turn the ends down, so he was obliged to cut the shaft off to the right length with a hammer and chisel. As there was a square shoulder on each end, he chipped and filed it down in order to get it in the piston and plunger and then riveted the ends over to take the place of nuts.

I saw the pump a year later, and it was running with the same rod. This impressed me as a very good job considering the crude facilities at hand.

A. C. HULL.

Hawthorne, N. J.

On Putting It Up to the "Old Man"

I am in charge of a central-heating plant, and am subordinate to a committee of three men. The chairman visits the plant for a few minutes on Sunday afternoon, which time he improves by raking me over the coals; he thinks that in this way he is doing his duty by the institution. This man I detest, because he has no judgment concerning my work. He did not know what packing was until I told him, and then he had the nerve to suggest that sash cord or clothes line would do just as well, and would be cheaper.

I have "put it up to the 'Old Man'" in this case in all kinds of shape and form, with proof and without, but it all has the same effect on the "Old Man."

The plant consists of two 72-inch by 16-foot, horizontal, return-tube boilers, and I carry, on the average, 15 pounds steam pressure. The heating surface amounts to about 18,000 square feet. About 80 per cent. of this is used continually.

I start the fires at 5.30 a.m. and run until 9 or 9.30 p.m., making a total run of 15½ to 16 hours a day. At 9.30 p.m. I bank the fires and shut off all steam in the pump room. I do this seven days a week for about eight months in the year.

I am required to run the heating plant, make all the necessary steam, water, and gas repairs, shovel snow and do scores of other odd jobs which compel me to leave the boiler house sometimes for indefinite lengths of time. I use from two to two and one-half tons of red-ash anthracite coal per day. The boiler room, in winter, is like an ice house, having a very poor roof made of galvanized sheet iron.

The continual cry is, "You are burning too much coal." I have suggested that changes be made so that the expense would not be so great, and have shown that by putting in new equipment from time to time, better economy could be obtained. But the "Old Man" cannot see it that way, because he does not understand, and he has the audacity to

fight those who do understand where economy can be effected.

If I want any fittings for making quick repairs, I am supposed to get an order from the "Old Man," and then chase to the city after one or two fittings, as the case may be. He will not sanction the idea of having a few fittings on hand. I have been asking for boiler compound for the last three years and succeeded in getting some only this last month.

The coal is contracted for by a local dealer and is delivered in truck-load lots. Formerly, when I needed coal, I had to ask the "Old Man" for a written order. In doing this, I always allowed plenty of time, but the "Old Man" was too busy at times with his own business and would forget to write the order. The consequence was that I would run out of coal and had either to telephone or write a note to the "Old Man" for the order. The dealer does not keep buckwheat coal, the size we use, on hand; consequently I would have to burn pea coal until a carload of buckwheat could be obtained, which usually takes about a week. This business is stopped now and I have the authority to order the coal direct. The result is that my coal bin is always very nearly full, so that in case bad weather should delay traffic, I have enough at all times to last for a month or six weeks. The complaint from the "Old Man" is that I keep too much coal on hand. I gues he is afraid that I eat it. Thus, in all matters pertaining to my duties, if I "put it up to the 'Old Man,'" he generally lets me down with my propositions like a ton of bricks. I would like to ask the men who are interested in steam plants this question: Is it advisable for an employer to become acquainted with his engineer, and why? A discussion of this question should be beneficial and it might come to the notice of some grouchy, grumpy employer and do some good.

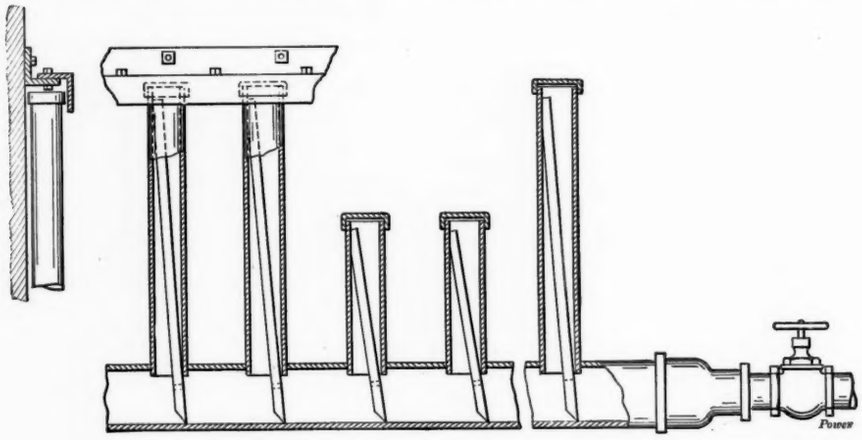
GEORGE PEHLMAN.

Philadelphia, Penn.

No Heat without Circulation

In the March 8 number of POWER I noticed several suggestions for making my heater work better, for which I am very grateful.

The way in which I got over the trouble is shown in the figure. The 1-inch vertical pipes made up more or less unevenly and as some of the upper ends were closer together than others, connections across the tops would have made a bad looking job. I took off the caps and inserted lengths of ⅜-inch pipe which extended to within 2 inches of the tops, somewhat in the manner suggested by J. W. Parker. The lower ends of the ⅜-inch pipes were cut off on a slant with a three-wheel cutter and had ¼-inch holes drilled through about 2 inches from the ends.



CHANGES MADE TO IMPROVE CIRCULATION

An angle-iron clamp serves to hold the heater in place.

W. CHINSANO.

Brooklyn, N. Y.

Jagged Exhaust Line

In regard to the indicator diagram which was submitted for criticism by F. W. Tross in the issue of February 15, it seems to me that the irregularity of the exhaust line, occurring in the middle of the stroke as it does, is due to the indicator rather than to the steam distribution. It could have been caused very easily by some one or something giving the pencil a jolt at that point. Since this is the only diagram showing this peculiarity out of several taken from the same engine, it would seem that either the attendant disturbed the pencil, or that it was accidentally jarred by some other means.

S. HURLEY.

Scranton, Penn.

In the February 15 number, F. W. Tross shows an indicator diagram and asks the reason for the jagged exhaust line. The diagram shows that he was carrying high back pressure. The back-pressure valve was loaded to get this pressure. When the valve fluttered and lifted to relieve the pressure, the indicator pencil registered the decrease of pressure. The increase above the back-pressure line is probably due to the inertia of the pencil motion.

A. C. WALDRON.

Lynn, Mass.

A Broken Drop Rod Pin

The "broken hook block bolt" of Mr. Griswold's article in the February 8 issue, is similar to an experience I had with a 22 and 48 by 42-inch cross-compound engine that gave trouble by several times breaking the drop-rod pin in the valve crank on the low-pressure steam valve.

The pin always broke as the valve closed, causing the valve to lap more than usual and remain closed, as the hook could not reach low enough to catch the block. The low-pressure cutoff was controlled by the governor, giving almost a constant receiver pressure of 10 pounds at all loads.

When the one valve became inoperative the receiver pressure increased and opened the relief valve at 30 pounds, providing I was not prompt enough in giving the other valve later cutoff. By giving the other low-pressure valve later cutoff I kept the receiver pressure from 20 to 25 pounds and the engine would continue in service along with another similar unit, both engines driving alternating-current generators in parallel.

The crippled engine would lag some and give a small part of its load to the other engine. I never kept the engine running long in this condition, never over an hour, or until the load could be reduced. And I fail to see any harm in running this way when circumstances demand it.

L. F. COOLING.

Dixon, Ill.

Powdered Graphite

Some time ago I gave an account of an experience which I had with powdered graphite as a lubricant. The results which I obtained at that time were not satisfactory. The graphite which I used was, it seems, of the quality used in making up stove polishes and paints and sold in bulk. It was not especially intended for lubricating purposes.

Recently, I received some special powdered graphite manufactured for lubricating purposes. I found that this graphite gave most satisfactory results. I mixed some of it with cylinder oil and used it on a piston rod. The rod became polished and stayed so for a long time.

I think that the reason why I did not get good results with the powdered graphite which I used originally was because it was not of the right quality.

H. JAHNKE.

Milwaukee, Wis.

The Influence of Mechanical Power*

Its Part in the Formation of Present-day Conditions. Systematic Study, Such as Its Development Has Required, Will Solve the Industrial Problem It Has Caused.

BY CHARLES EDWARD LUCKE †

The modes of life, habits, comforts and pleasures of the great masses of the people were greatly changed by the introduction of power-driven machinery which began when James Watt applied his steam engine to the driving of textile machinery one hundred and sixty years ago.

This industrial change was briefly reviewed in the first lecture of this series. The magnitude of present-day industries which did not exist before Watt was pointed out as well as was the ever increasing proportion of the population directly dependent upon them for wages and salaries, the equally large number of traders or merchants supplying raw material and distributing manufactured products, the absolute dependence of all of us on the manufactures and transportation systems for all that we need and the importance to all of at least trying to understand how all this has come about.

With such world-wide questions before us, why, then, has so much time been spent in discussing the construction of steam boilers, gas producers, engines, turbines, nozzles and valves, and in studying the principles of gasification and combustion of fuel, the generation and expansion of steam or the flow of water, when, instead, attention might have been directed to the more popular questions of industrial growth itself, its effects on the organization of society, the creation and distribution of wealth or the government of the people? Because these questions, which are of infinite complexity as compared with the economic generation and application of power to machines, have been discussed by economists, sociologists, historians and statesmen, while the power question, which is so large a factor and so strong a formative force, has never been presented to a popular audience; finally, and by no means least, because it is the finest possible example of the value of patient, logical, scientific study, in resolving complexity into comparative simplicity, yielding to exposition and serves as a model of the method to be applied to the apparently more complex and larger questions. Place before the average man a collection of all the standard power-generating machinery and it would not be too much to say that he would at once admit its explanation and creation to be far more difficult for him to discuss than a question of politics or economics, on all of which he has some well defined opinions, and yet these are far more difficult to solve than any machinery problem. How much more cautious, then, should we be in reaching conclusions and how much more needed is a method of procedure that is safe and sane. Who could have foreseen the tremendous effects of studying wheels, cylinders, rods and chambers and the design of these to carry out processes of rendering available for man's use nature's energy to change into useful forms the substances of sea, farm, forest and mine? Probably no one. It is not surprising, then, that the average man has a feeling that there is no connection between his needs and pleasures, his commercial or social standing, his opinion or mode of thinking and the dirty shop, the hot and mysterious engine room, the laws of thermodynamics and hydraulics and their application to machine structures or any other part of the problem of power generation and application. Yet there is a twofold connection. Without these things the world would not be what it is today, and the methods and principles involved in the creation of the machinery have revealed Nature herself, and are equally applicable to the other problems which seem of more intimate importance. No man can afford to fail to inquire into all that concerns his welfare, more especially those things that may serve to guide his thinking, which controls action; yet it is all too true that not only has the study of industrial development and its effects been neglected by the public in general, but the work and methods of the scientific engineer, who is responsible for it, are practically unknown.

During all the time which the engineer has devoted to creating or applying machinery for the most economic use of Nature's energy, he has had constantly to meet the parallel problem of making the best use of the efforts of man himself, for results are obtained not by power alone, by machinery alone, nor by men alone, but by all working together. It is, therefore, just as much the duty of the engineer who began by studying Nature's substances and forces to study also the forces controlling men, so that each individual may contribute the best that is in him just as in the case of an engine itself. This parallel study of the economic use of man's efforts has been placed on a scientific basis only in recent years and from present indications is destined to receive as much painstaking analysis in the future as it has lacked in the past, which lack was the cause of much disorder, misery, abuse and social unrest in the early days of industrial expansion.

Without doubt, the use of machinery and power is on the increase; every machine is constantly being studied to devise ways of improving it. The deep study of the efficiency of labor, its proper compensation and welfare will receive ever increasing attention of the analytical sort. The effects of all this will be in the main beneficial and elevating, so that the nation may make the greatest progress. What effect, then, will all this have on the conditions of living in the future? Will the flow to the cities continue, will more manufacturing cause more cities, and if so, how is this tremendous congestion of population to be housed and fed? While it is true that in the early days the factory created the city, today it is not; it is breaking up the city and the reason is sound. High efficiency of process and low cost of production demand saving in every way possible; thus the factory that can do its work in the country or small town simply cannot afford to stay in the city. It does not take a highly refined study to show how absurd it would be to build a steel works at Broadway and Wall street, when there are thousands of square miles of cheap land within the reach of railroads. This fact alone will be sufficient to explain the tendency now so common and ever on the increase of relocating factories in small towns or creating new towns in the open country as is being done at Gary, Ind., by the United States Steel Corporation, and indicates that the city, if it is to increase at all, must find that increase based on other causes. Statistics show that while there is still a flow toward cities it has changed in character. Weber in his "Growth of Cities" says, "the most rapid rate of increase of population is found in villages and small towns (2600 to 8000) which are chiefly dependent for their prosperity upon manufacturing industries. The great cities, centers of trade and commerce, nearly rival the villages in rate of growth." Here, then, is the key—the large cities are becoming, not the centers of manufacturing, but centers of trade and commerce and their location and growth is now traceable to two causes, commercial and social. They will locate wherever there is a break in the trans-

*Abstract of the last Hewitt lecture delivered March 28 at Cooper Union hall, New York City.

†Professor of mechanical engineering in Columbia University.

portation—railroad terminals, shipping ports or points of transfer are to be city sites as they always have been. Their growth seems to be dependent mainly on social conditions described by E. S. Smith as follows:

"Man naturally loves company and good fellowship. This seems to be the real basis of the drift from farms to the cities. All the attractions of city life are spread by the literature of the day. Men come to know more about the life outside of their own little horizon and become restless to share other and more attractive callings. In the country it is quiet, with few pleasures, but in the city there is hurry and excitement, the stir and push of business, amusements of every sort, resorts of every grade where men may congregate and pass the time in congenial companship."

While, therefore, as a result of good transportation and cheaper land in the small towns the manufactures will no longer be casual influences in city growth, they do, nevertheless, draw more and more on the farm or food-producing element of the population which must be recruited when the danger point is reached, not from the manufacturing and transportation-working classes but from the small-trader class, with which the large cities swarm and who seem to prefer an approach to starvation in the excitement of the city with but light labor to good, honest, hard work on the farm or in the factory. This danger point will not be reached, however, for some time to come, for, although the farm population has been ever on the decrease in proportion to the number of city dwellers, the output of the farms has been kept up fairly well due to the application of the same principles of efficiency so highly developed in manufacture.

Plowing may be done by traction engines run by gasolene or kerosene, the seed planted by horse-drawn machines. By machinery grain may be cut or corn picked and threshed or shelled ready for market, cream separated from milk, churned and butter made and water pumped for stock and irrigation. All of this removes the drudgery and together with the rotation of crops, cultivation and the use of proper fertilizer and insect-destroying methods, enormously increases the productiveness of both the ground and the man who tends it. In America, we have never had an abundance of farm labor but the American inventor has surpassed the world in his ability to devise machines and methods, without which this country could never have been supplied with food; and this same system which has rendered efficient the manufacturing system may be relied upon to continue to build up with continued and permanent prosperity that nation which teaches its sons how patiently to study the little things which control the big ones.

Gain by Expanding to Low Pressures

In naval reciprocating engines it is well known that, owing to considerations of weight and space, a large expansion was not given at full power; in other words, economy at full power had to be sacrificed to other requirements in the warship compromise. Taking a number of representative reciprocating engines for our more recent warships with a fairly high steam pressure—viz., about 220 pounds per square inch by gage in high-pressure receiver—the average pressure at the completion of the expansion at full power is 12½ pounds absolute, with a back pressure, while the cylinder is open to the exhaust, of 6.7 pounds absolute, the average vacuum being 26 inches, or, say, an absolute pressure of two pounds per square inch.

Further, while the average back pressure in the low-pressure cylinder was about 6.7 pounds absolute, or 16½ inches vacuum, the expansion only extends while driving the piston to about 12½ pounds absolute, or 5 inches vacuum, so that a considerable percentage of the energy in the steam which could be obtained by gradual expansion from 12½ to 6.7 pounds while doing work, is also lost.

In the turbine, however, instead of these comparatively high pressures at the termination of expansion, we have the fact that the steam does useful expansive work to about 27 inches vacuum at the turbine end, with a vacuum of 28 inches in the condenser, the necessary volume being obtained as indicated previously. At the other end of the scale the average steam pressure at the turbines has only been about 140 pounds in recent examples furnished by turbine ships of the British fleet.

Assuming adiabatic expansion, the following table shows the energy available in thermal units per one pound of steam when expanding between various pressures, and the comparatively large amounts obtained for small drops of pressure at low pressure:

Expanding from 235 pounds absolute to 16½ inches vacuum, 249 thermal units.

Expanding from 16½ to 20 inches vacuum, 16.2 thermal units.

Expanding from 20 to 22 inches vacuum, 11.8 thermal units.

Expanding from 22 to 24 inches vacuum, 15.1 thermal units.

Expanding from 24 to 26 inches vacuum, 21.4 thermal units.

Expanding from 26 to 28 inches vacuum, 31.9 thermal units.

It will be seen that the B.t.u. given up by the steam expanding adiabatically from a vacuum of 16½ inches to one of 28 inches is 38.7 per cent. of the B.t.u. available from an adiabatic expansion from 235 pounds absolute to 16½ inches vacuum, showing the great gain by the economical expansion to low pressures, and explaining the superior economy of the turbine—H. J. Cram, engineer-in-chief of British fleet, in *Engineering*.

Splitting Hairs and the Real Trouble

The old timer came in Saturday and sat on the corner of the editor's desk. The senior philosopher was trying to edit one of those discussion letters where the writer was splitting hairs on nonessentials. He put the question up to the old timer.

"That reminds me of a time when I was railroading," said he, taking a cigar out of the editor's box. "I was traveling engineer for a grim old master mechanic who could smell a lie and see through a man better than a police judge.

"One day in comes an engineer who had been fired a few months ago for burning a boiler—State's prison offense on a locomotive. He wanted his job and his reputation back, and the old man listened to his argument very patiently, and, both the plug puller and I thought, with growing favor, so the crown sheet cook warmed to his subject, the gist of it all being that he had water to 'sell' when the crown sheet went down and something else must have softened up the crown bolts so that the heads peeled off like mushroom tops.

" 'Yes, Jim,' says the old man, 'mebby you're right, mebby you're right, but there's jest one thing this company, nor me either, can't overlook, and that is this, *it's just as bad to burn 'em with water as fire!*' "

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Power and The Engineer

Editorial

Advanced Education for Naval Engineers

Engineering as a profession has this feature in common with most others: that it is a union of a science and an art. Its practitioner must be both able and well informed in the handling of nature's laws as a matter of formulated knowledge; and also must be proficient in the craftsmanship by which such knowledge is applied to practical affairs.

In some branches of engineering the emphasis has been unduly strong upon one side or the other. The designer and creator who is concerned with the general principles of science, and to whom the practical details are inconsequential, has looked down upon the engineer who makes things go. He has called the latter a machinist, an artisan, and denied him a place among professional men. The practical type, on whose shoulders rests the responsibility for effectiveness of the real engine, has claimed for himself the title of engineer, basing the claim upon what he knows how to do, and does. Both parties are partly right and partly wrong. As the pendulum swings from the well informed practical engineer away from the scientist, the engineer passes into the engine runner; as it swings from the practically experienced man of affairs toward the researches into pure theory or abstract design, the engineer becomes the scientist.

Two notable examples of types of engineer exposed to a temptation to undervalue the scientific outlook of engineering are the locomotive engineer and the naval engineer. They appear so much in the public eye as operators, as practical masters of existing machines, that the public has been tempted to see only this mastery and to neglect the intellectual side or the mental qualifications no less necessary or important which enable the real engineer to create an existing machine from a previous nonexistence. Both consideration and pay become attached to what the engineer does, rather than to what he knows, or knows how to do, in a practical and work-a-day world.

The occasion for these comments is a recent study of a new development in the course of education for the engineer officers of the United States navy. It is the purpose of existing legislation to make every naval officer an engineer, which is the result of an awakening to the fact that a modern battleship or cruiser is a machine pure and simple. Its design is an engineering problem of the highest class; its operation and upkeep call for the craftsman-engineer of the best type; the navigation of it as a detail of pure seamanship becomes a very secondary matter so far as previous training is required.

But the danger which is present whenever the side of the craftsman becomes paramount is also to be guarded against. There are many questions to come up to the naval engineer, particularly as he advances in rank, which the skill and experience of the mere craftsman-engineer will not be enough to meet. In recent years these have been many and varied. Shall the water-tube type replace the shell boiler, and if so, what form of water-tube boiler shall be preferred? Has the semi-flash boiler a field in the navy? Shall the turbine replace the reciprocating engine in any class of vessel, or in all classes, or in some classes and not in others? Shall the high-speed geared type of steam turbine be preferred to one in which the reduction of speed and transmission of power is effected electrically? Has the internal-combustion engine using carbureted-air gas a field in the marine group, and can producer gas be used with advantage? How big ships can be propelled advantageously by gas engines? Is there a gas turbine to come for marine propulsion?

Then beside this, there is the field of applied science in engineering matters concerned with the properties of material used in construction and the wise selection of auxiliary devices and supplies for ships and their motive power; the design of better, safer and more reliable ammunition hoists and turret-manœuvering machinery, and the problems of transmission of energy thereto from the central power plant of the vessel. It was an old fallacy adhered to obstinately by some good men up to a very recent date, that a warrant machinist could be made into a good naval engineer, and no better type was called for. The above list of insistent problems should be answer enough, at the present day.

Is the United States taking any steps to meet these advanced and higher requirements for the naval engineer and officer of the twentieth century? It is, and most intelligently. The present plan in effect at the naval academy at An-

napolis in Maryland, gives the naval apprentice or midshipman a stiff four years' course in mathematics, physics, chemistry and drawing, with work in the pattern shop, foundry, forge and machine shops as a basis for his engineering study. This latter covers mechanics, steam engineering, strength of materials, electricity and engineering-laboratory work; but unfortunately the standard cannot be brought up to that of the best civilian engineering schools in these matters, because first the lads enter at sixteen years of age, and secondly there must be introduced courses in ordnance, in navigation and the practice of seamanship, which are not required ashore or in civilian branches of the profession. The time for these special naval subjects and for practice cruising has to be taken from that which the landsman has at his disposal.

To meet this difficulty and to accomplish a wise purpose in addition, the present engineer-in-chief has authorized and favored a post-graduate school. This is made up of a limited number of young officers who have seen service ashore and afloat, who are ambitious to pursue further professional study, and who are mature enough to pursue such advanced study with advantage. They are chosen by competition in examination and service record; and should therefore be the cream of the service as respects ability and high purpose to excel. Most of them have been out about ten years. Returning to the academy with eyes opened to the requirements of their profession, with habits of hard work formed and of self-reliance because of contact with the actual world of affairs; these men are an ideal type of student. Ten only are admitted in any one year; and the detail from active service at present is for not over two years. The best method of instruction will not be by the formal class-room or lecture treatment of topics, but rather the method of individual contact of student and instructor in conferences—what is called in Germany and in university post-graduate instruction in this country, the "seminar." The student does his own reading in the field of research, guided by indexes and the instructor's criticism, and reports at intervals, longer or shorter as cases may demand. He has also the laboratory and the shops at his command to bring his deductions to the bar of test. A well equipped general and special library and a growing card index and files are, of course, the necessary tools of this system. To bring the broader outlook of the civilian practitioner, the manufacturer and producer into touch with the learner, the department has arranged for lectures by men in this class who may have a message of experience to give; and the methods of thinking and of work of such men are opened up in the contact with them. It would seem that the proposed plan has in it the concepts of a wise planning to enable the naval engineer of the future to meet the demands of a broad scientific and professional outlook.

Tube Failures

The number of recent boiler-tube failures in the Middle West, on naval vessels and elsewhere, serves to call attention to the seriousness of this class of accident. Any considerable rupture in a tube will open up an avenue for the escape of the contents of the boiler equal to twice the area of the tube and this, as we have seen in a number of recent instances, often means the scalding to death of one man and perhaps several who may be near the boiler. It has long been known that insurance companies favor as a risk the horizontal return-tubular boiler in preference to the water-tube type. This is on account of the great number of joints in the latter and the small areas which can be quickly stopped up with scale or mud. Of course, when a shell boiler lets go, the damage is generally much greater than in the case of the water-tube variety, as the failures in the latter are more often in the tubes of small diameter. However, in the rare cases where the drums of a water-tube boiler explode the damage is fully as great as in the case of the tubular type, as we have had occasion to see recently in this country.

While in spite of all precautions there will occasionally be failures in boiler tubes, it behooves those in charge of the operation of boilers to exercise every endeavor to reduce them to the minimum. Inspection cannot always detect a defective weld, neither is the hydrostatic test infallible. It is possible to know that the boiler tube is clean and that the wetted surface has a good full contact with the water, for other things being equal, the possibilities of a clean tube full of water giving way are much less than when conditions are otherwise.

There is a tendency in taking care of boilers to clean oftenest only the tubes nearest the fire, leaving the ones farther removed for attention possibly at every other cleaning. In the case of horizontal boilers this is not so serious as the circulation does not depend on the neglected tubes, water being supplied from the horizontal drums above, to the back manifolds. A very small piece of loose scale, however, in a horizontal tube, has been known to produce a blister and finally a leak, and for this reason the practice should be guarded against as one likely to make trouble.

In the case of vertical boilers the back tubes are relied on to furnish the water which is evaporated in the front part of the boiler. If sediment is allowed to accumulate in these back tubes until there is any perceptible restriction in the circulation, it is bound to affect conditions in the front tubes, increasing the percentage of steam bubbles as compared with the solid water, raising the temperature of the metal and seeking out imperfections if they exist. Moreover, conditions in the back tubes are more favorable for the depositing of impurities, so that these tubes should be closely examined every time the boiler is opened.

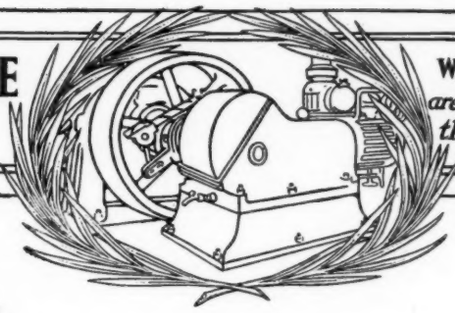
Another point of importance is making proper use of the blowoff. This is realized in marine practice where the water becomes dense due to the presence of salt, but it is not always appreciated in stationary work. It should be remembered that in the average plant using ordinary feed water, the effect of evaporation is to concentrate the impurities in the boiler. In one test, of a few days' duration without blowing off, the density increased from 25 grains to the gallon at the start to 750 grains; and it takes but a comparatively short time if the water is not changed by blowing off to get a solution containing over 1000 grains to the gallon. There is a marked difference in the quantity of heat absorbed under these conditions, which is unfavorable alike to efficiency and longevity of the boiler.

After having selected the best material, subjected it to frequent inspection, taken pains to know that the heating surface is maintained in a commercially clean condition and that the density of the boiler water is kept within reasonable limits, while the tube failures will not be absolutely prevented, still there will be the satisfaction of knowing that everything within reason has been done that can be done to prevent them.

The capture of several big contracts in this country by the Germans has a significance not flattering to American manufacturers. The Rhenish-Westphalian works have contracted to build three more 10,000-horsepower turbines for the Niagara Falls power plants, which will make fifteen in all with a total horsepower of 150,000. Other German firms have obtained orders to build a series of large coke ovens for the Bethlehem Steel Company. The order includes 400 ovens with a capacity of 3000 tons a day, and the cost will be about $4,500,000.

It is rumored that the New York, New Haven and Hartford Railroad is about to build a large power station, in which reciprocating engines will be used in connection with steam turbines. The station will be new from the ground up, and this will be the first instance, of which we have learned, where engines have been bought new for use in series with turbines in this way.

NEW POWER HOUSE EQUIPMENT



WHAT *the* INVENTOR *and the* MANUFACTURER *are* DOING *to* SAVE TIME *and* MONEY *in the* ENGINE ROOM *and* POWER HOUSE

The Moffatt Improved Double-Acting Pump and Heater

This combination pump and heater is manufactured by the Park Manufacturing Company, Charlotte, N. C. It is designed for use in steam plants ranging in sizes from 60 to 300 horsepower. The pump is attached to the heater, which reduces the space necessary for installation as well as the length of piping between the pump and heater. It is belt driven and geared five to one, thus making a smooth-running pump.

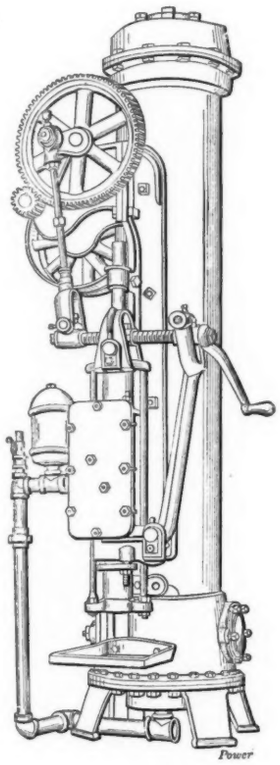


FIG. 1

The pump proper consists of two plungers, the heads of which are connected by side rods, which give the double action. The plungers are outside packed. A feature of this pump is the adjustability of the plunger throw. The crank rod is attached to a threaded rod, which passes through a threaded head on the plunger, with a bearing on the outer end at the hand crank. This allows the adjusting of the length of the plunger stroke by lengthening or shortening the distance between the threaded bearing on the plunger and the lower end of the crank. In this way the objectionable feature of inability to control the feed-water supply is overcome.

On the discharge pipe a safety valve is placed, so that in case the globe valve between the pump and boiler has been left closed, no damage can be done to the pump, as the valve will relieve it of excessive pressure.

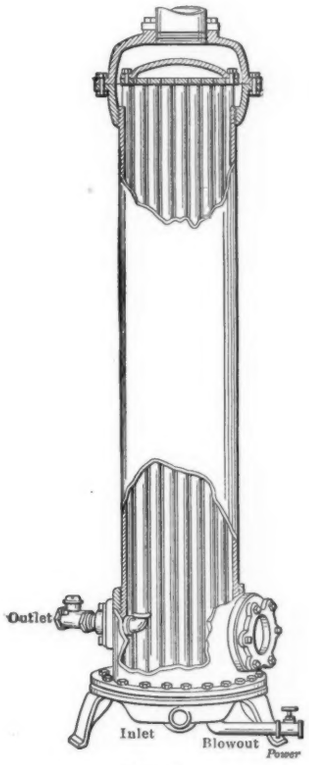


FIG. 2

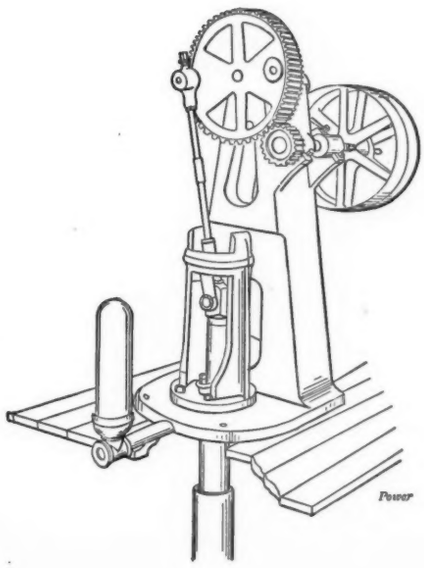


FIG. 3

The heater portion consists of a series of straight brass tubes rigidly fixed in the lower head. The upper head is capped as shown in Fig. 2, and comes entirely within the shell. This allows the exhaust steam to pass around the tubes on all sides, also the cap. This design makes the shell and tubes entirely independent as regards uneven expansion and contraction. By removing the cap and upper head, the tubes are easily accessible for cleaning, etc.

A design of pump head, known as the "deep well pump working head" is shown in Fig. 3. It is belt driven, being geared five to one. As the frame is of a heavy design, an electric motor can be bolted to the standard and connected by pinions and gear to the countershaft.

The stroke is adjustable to 10, 12, 14 and 16 inches.

Another feature is that the top of the plunger is fitted to a crosshead running in guides which are detachable, so that in case the plunger rod and valve of the pump are to be taken out, the pump frame need not be removed, merely the crosshead casting.

Wilkinson Safety Water Tube Boiler

A new type of safety water-tube boiler has recently been put on the market by the Oil Well Supply Company, Pittsburg, Penn. The accompanying illustrations show the several features of this boiler.

The boiler is shown in front and side elevation, illustrating the headers in circular form, and also the layout of the tubes. The peculiar layout of the bottom row of tubes provides an equal distribution of the products of combustion along the entire length of the tubes, and also permits of a larger area for the combustion of the gases, than would be the case if the tubes were on a horizontal line.

The horizontal sectional elevation shows the manner in which the inside and outside header sheets are connected together. The sheets are flanged by what is known as the spinning process, and when finished are pressed one into the other and then riveted with a single girth seam, the calking edge of which looks outward and can be examined at all times without interfering with the brickwork.

The headers, being made in circular form, cause all foreign substances to

collect at one point at the bottom, and as there are no corners where sediment or scale may lodge, they can be easily cleaned by blowing off.

Another feature of this boiler is the manner in which the drum is connected to the inside header sheet, which is flanged out to meet the drum shell, thus leaving a clear passage from the drum to the header. As no straps or bars are used in connecting the header with the drum a free circulation of the water from the headers to the drum is obtained; consequently, a free liberation of steam. The inside of both header sheets can be examined and cleaned with a hose by entering the drum through a manhole in the rear head.

The tube handholes can be removed for cleaning-out purposes, but to thoroughly examine this boiler it is not necessary to remove the tube handholes.

The dry pipe is located well to the front and is protected by a system of baffling which, it is claimed, makes it impossible for any water to pass over into the separator. The feed is introduced through the front head of the drum through a pipe leading into the settling chamber, the end of which is tapped for a surface blowoff.

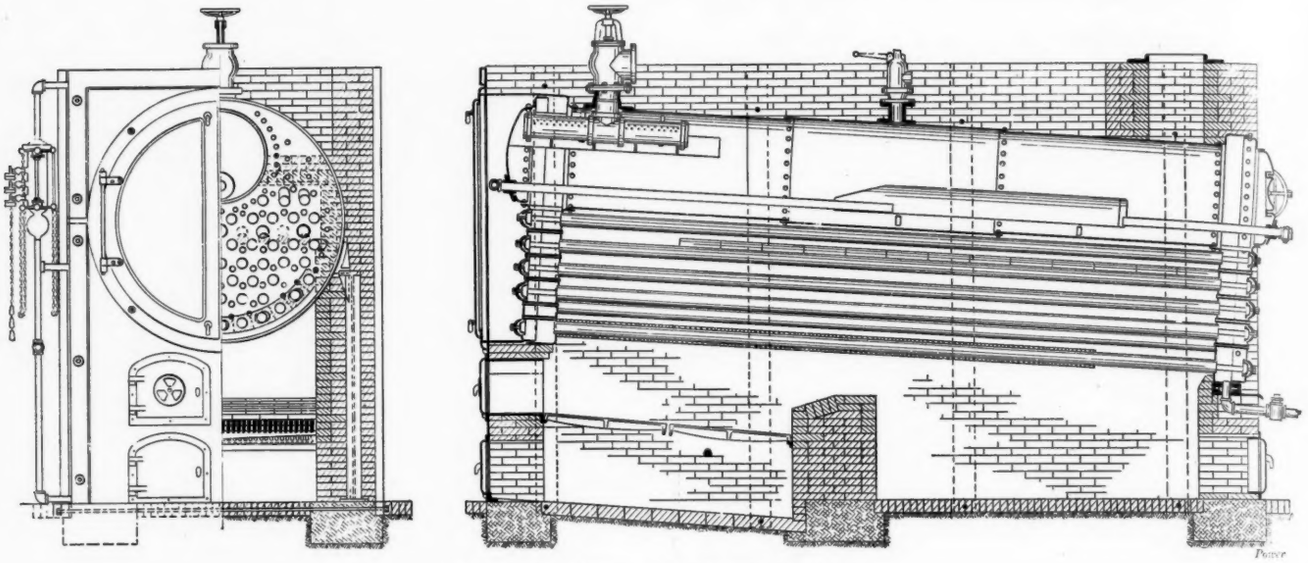
The lower row of tubes are incased with special locking firebrick, forming the lower baffle. This is to prevent the water in these tubes, which are subjected to the hottest part of the fire, from being driven out by the very rapid circulation. These locked baffle brick cannot possibly fall out of place, it is claimed, although they are easily removable for repairs. The upper baffles are laid on the tubes in the usual manner.

No side cleaning-out doors are necessary, as the tubes can be blown out from both front and rear through hollow stays, each stay taking care of four tubes.

These boilers are built in units of from 50 to 500 horsepower, and for a safe working pressure of from 160 to 250 pounds. They are all-steel construction throughout. The tubes, being straight, can be removed from either front or rear end, and all handhole plates are made fast from the pressure side, and fitted with a special type of asbestos metallic gasket.

The boiler is suspended by a system of steel beams and hangers, which allow it to expand and contract in all directions, without injury to itself or to the brickwork.

All headers in units of 350 horsepower and upward are fitted with double drums, and all units below 350 horsepower with single drums of such dimensions as to give unusually large steam-storage capacity.



WILKINSON SAFETY WATER-TUBE BOILER

New Head for Boiler Tube Cleaner

The Lagonda Manufacturing Company, of Springfield, O., has recently put out a new cleaner equipped with what is known as the "quick repair head." The head is attached to the turbine proper by means of the coupling and an adapter. As can be seen from the accompanying illustrations, a spider screws directly into the coupling, and has three arms on the ends of which are attached the swinging arms carrying the cutter wheels. There are four cutters on each swinging arm; the front one, being of the cone pattern, is the first to attack the scale and loosen it. Each cone cutter is then followed by three star cutters which remove the scale down to the metal, leaving a bright, polished surface.

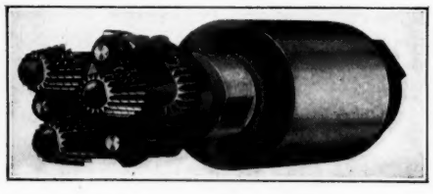


FIG. 1. QUICK-REPAIR HEAD

The most important feature of this head is the ease with which new cutters can be inserted. The cutter pin can quickly be removed by means of a wrench and all of the cutter wheels taken out. To take the entire head apart it is only necessary to unscrew the spider from the coupling; this allows the three arm pins to drop out and the whole head is dismantled. There are no rivets or small parts used and as the makers furnish an extra supply of sharp cutter wheels with each head there is no reason why any operating engineer should struggle along with dull cutter wheels.

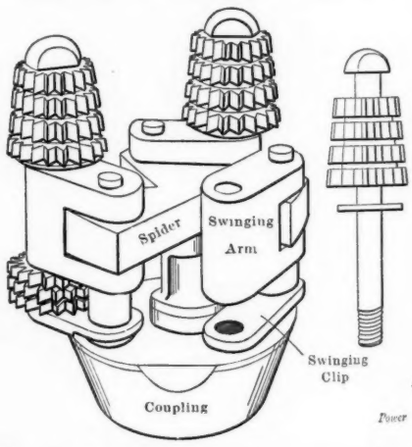
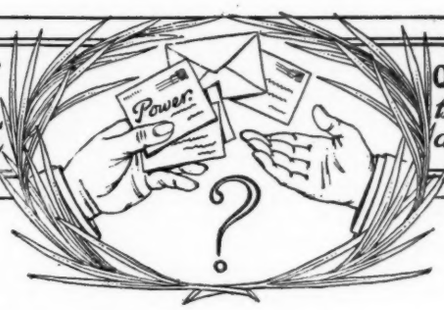


FIG. 2. QUICK-REPAIR HEAD WITH ONE OF CUTTER PINS REMOVED

The head is compact and heavily built. The arms are thrown out against the scale by the action of centrifugal force. This causes the cutter wheels to bear firmly against the scale, but should a constricted part of the tube be met the arms fold in and do not injure the tube.

INQUIRIES of General Interest



QUESTIONS are NOT ANSWERED UNLESS they are ACCOMPANIED by the NAME and ADDRESS of the INQUIRER.

Equal Clearance

State how to determine whether there is equal clearance at each end of the cylinder and if there is more clearance at one end than at the other end how to regulate it.

G. H. I.

Equality or inequality of clearance is readily determined by inspecting indicator diagrams from both ends of the cylinder. Piston clearance is determined by disconnecting the connecting rod and pushing the piston to one end of the cylinder until it strikes the head and marking the guide at one end of the crosshead, then pushing the piston until it strikes the other head and again marking the guide. If when the rod is connected the crosshead travels equally between the marks on the guides the piston clearance is equalized. If the travel is not equal, shims may be put between the ends of the rod and the brasses to lengthen the rod where the wear shortens the distance between the centers of the boxes. If as in some forms of rod ends the wear lengthens the rod, shims may be put between the brasses and the outside or strap end of the rod.

Piping Required to Cool Room

I have a room that I wish to cool by the direct-expansion ammonia system. The room is 30 feet long, 15 feet wide and 12 feet high. How many feet of 2-inch pipe would it require to maintain a temperature of 40 degrees in the room, assuming the outside temperature to be 80 degrees and the room well insulated.

C. W. M.

We regret that no specific advice was given regarding the nature of the products to be stored in the cold-storage room you mention. This is absolutely essential in order to accurately estimate the amount of cooling capacity required. It is also necessary to know the construction of the cold-storage insulation, as a large percentage of the cold piped into cold-storage compartments is lost by radiation through the insulation. Assuming, however, that the box in question is for the storage of general products, such as a large-sized hotel box, the rule employed by builders for apportioning the pipe to the cubical contents of a room of approximately 5000 cubic feet, to be maintained at 40 degrees Fahrenheit, would be as follows:

Size of pipe, inches	2	1¼	1
Ratio	13	8.8	6.3

If the nature of the box is more like that of a cold-storage house, the following ratios would be employed:

Size of pipe, inches	2	1¼	1
Ratio	15.2	10.4	8.2

The piping, according to the above ratios, will look after an ordinary amount of opening and closing of doors, reasonable insulation losses and the storing of miscellaneous products at ordinary temperatures.

If it happens that hot, freshly killed carcasses are to be stored, you should allow extra for each 1000 pounds of product stored; the following number of lineal feet of pipe should be allowed:

	2" Pipe.	1¼" Pipe.	1" Pipe.
Large beef	65 feet	92 feet	117 feet
Small beef	55 feet	78 feet	100 feet
Hogs	50 feet	70 feet	90 feet
Calves	45 feet	64 feet	80 feet
Sheep	40 feet	56 feet	72 feet

On the basis of the above ratios the number of lineal feet of pipe of different sizes required for cooling your cold-storage compartment of 5400 cubic feet, but not providing for the cooling of hot carcasses, would be as follows: 2-inch, 415 feet; 1¼-inch, 613 feet; 1-inch, 857 feet.

Changing Speed of Engine by Governor

How can the speed of an engine be changed by the governor?

J. B. A.

With the pendulum governor the speed of the engine can be changed by altering the diameter of the governor pulley. Increasing the size of the pulley will cause the engine to run faster and decreasing it will reduce the speed.

With the centrifugal and inertia governors changes of speed are brought about by changes in weights or their position and by changes in spring tension, an increase in tension increasing the speed and an increase in the weights decreasing the speed.

Mean Effective Pressure

What would be the mean effective pressure with a boiler pressure of 80 pounds and cutting off at one-quarter stroke?

D. E. F.

The average pressure of expanding steam for any ratio of expansion is found by multiplying the hyperbolic logarithm of the ratio of expansion plus 1 by the absolute pressure and dividing by the ratio of expansion. With boiler pressure realized in the cylinder and clearance neglected, the solution would read

$$P = \frac{(1.3863 + 1) \times 95}{4} = 55.66$$

pounds absolute. Subtracting 15 pounds absolute back pressure gives 40.66 pounds mean effective pressure.

If only 75 pounds pressure obtained in the cylinder and there was 5 per cent. clearance, the actual cutoff would be 0.3 of the stroke and the ratio of expansion would be 3.33 and the solution would read

$$P = \frac{(1.2030 + 1) \times 90}{3.33} = 59.5$$

absolute. Subtracting atmospheric pressure as before, the mean effective pressure would be 44.5 pounds.

Rate of Condensation

An iron tank or receiver, 8x24 feet, is kept full of steam at 10 pounds pressure. How much will be saved by a good nonconducting covering?

J. A.

Under average conditions of protection from the weather, the 703 square feet of radiating surface would condense about 50 pounds of steam per hour. With a good nonconducting covering only about 20 per cent. of this condensation would take place. The cash saving would depend on the cost per pound of steam used to fill the tank.

Cutoff and Ratio of Expansion

In a 12x18-inch engine with 5 per cent. clearance the cutoff takes place at 6 inches from the end of the stroke. What is actual cutoff and ratio of explosion?

P. D. W.

As there is 5 per cent. clearance the total volume of the cylinder expressed in terms of the piston displacement is 1.05 and there is a volume of steam equal to 5 per cent. of the piston displacement in the cylinder before the piston moves at all. If the cutoff occurs after the piston has traveled 12 inches or 66.6 of its stroke there will be 66.6 per cent. plus 5 per cent., or 71.6 per cent., of the cylinder volume filled with steam. In other words, the actual cutoff is 71.6 per cent. in terms of piston stroke.

The ratio of expansion may be found by dividing the final by the initial volume. If 1.05 represents the final and 0.716 the initial volume the ratio of expansion is 1.46.

NEW PUBLICATIONS

"Unit Coal and the Composition of Coal Ash," by S. W. Parr and W. F. Wheeler, is issued by the engineering experiment station of the University of Illinois as Bulletin No. 37. By unit coal is meant the organic material which is involved in combustion, as apart from the mineral constituents which, in their natural state, enter into the composition of all coals. From the experiments described in the bulletin, it appears that when similar cases are compared, the variations in composition are chiefly in the extraneous matter; that for a given district, and more especially for a given mine, the value of the unit coal is practically constant. The heating value of the actual coal may vary considerably, but when the portion of the whole which is not coal is eliminated, the resulting material is of constant value.

Tables exhibit the thermal and chemical properties of coals, chiefly from Illinois, but also from other portions of the United States. Attention is called to the necessity of careful methods in determining the ash content. Certain districts, especially in Illinois, contain a peculiarity in the ash composition, heretofore overlooked, viz., the existence of calcium carbonate in sufficient quantity to make it advisable to modify the usual ash determination to account for this constituent, which may occasionally be met to the extent of 5 or 6 per cent. of the total weight of the coal. Copies of Bulletin No. 37 may be obtained gratis on application to W. F. M. Goss, director of the engineering experiment station, University of Illinois, Urbana, Ill.

Books Received

"Producer Gas Fired Furnaces." By Oskar Nagel, New York. Cloth; 184 pages, 5¾x9 inches; 237 illustrations; tables; indexed. Price, $2.

"Corrosion of Iron and Steel." By Alfred Sang. McGraw-Hill Book Company, New York. Cloth; 127 pages, 4¾x7¼ inches; indexed. Price, $1.

"The Indicator Handbook." By Charles N. Pickworth. D. Van Nostrand Company, New York. Cloth; 134 pages, 4¾x 7¼ inches; 146 illustrations; tables; indexed.

"Engineering Thermodynamics." By C. F. Hirshfeld. D. Van Nostrand Company, New York. Cloth and paper; 157 pages, 3½x6 inches; 22 illustrations. Price, 50 cents.

"Fuel and Refractory Materials." By A. Humboldt Sexton. D. Van Nostrand Company, New York. Cloth; 364 pages; 4½x7 inches; 104 illustrations; tables; indexed. Price, $2.50.

"Flying Machines." By Rankin Kennedy. The Technical Publishing Company, Ltd., London, England. Cloth: 158 pages; 5x8 inches; 62 illustrations; tables; indexed. Price, five shillings.

Boiler Explodes at Bowling Green, Kentucky

On March 28 a tubular boiler, 52 inches in diameter and about 12 feet long, exploded at the sawmill of F. L. Kister, Bowling Green, Ky. One killed, two seriously injured and considerable damage to property are the results of the explosion. It is reported that there was a long blister on the bottom sheet of the shell, and of the six braces at the front head, only one was holding.

Stevens Institute Asks Exemption from War Tax

The trustees and alumni of the Stevens Institute of Technology, Hoboken, N. J., have undertaken active measures to recover a sum of money—$45,000 and interest—which was paid to the United States Government as an inheritance tax in 1870. Promptness in payment is now known to have been the real cause of the institute's loss, for other charitable and educational institutions, which delayed, were exempted by special laws.

The tax was paid in accordance with a war measure, made necessary by the extraordinary needs of the Government. When Edwin A. Stevens died and left $650,000 for educational purposes, the bequest was assessed $45,750. Less than one month after the receipt of the bill from the internal-revenue collector, the tax was paid.

Repeated efforts to recover the above sum have brought no result. The trustees petitioned Congress again and again. The appeals being met with indifference, efforts ceased for a time. Finally Dr. Alexander C. Humphreys, the present president, undertook to have the matter recalled to the attention of Congress.

A bill allowing the money has been introduced in each house, and President Humphreys has pledged himself that, if the money is allowed, every cent of it will go to swell the institute's endowment.

The Stevens Institute was the first to establish a college of mechanical engineering, and the many colleges now engaged in that branch have followed the lines laid down at Stevens. At the present writing there are 1500 graduates of the institute.

SOCIETY NOTES

On April 5, 6 and 7, the Southern Supply and Machinery Dealers' Association held their annual convention in Jacksonville, Fla. Numerous papers were presented, and in general the meeting proved a great success.

At the March 8 meeting of the American Society of Mechanical Engineers, New York City, the secretary read an invitation of President Aspinwall of the Institution of Mechanical Engineers, to members of the Council and past presidents of the society, to a dinner on the evening of Monday, July 25. A total of 208 are planning to attend the joint meeting in England in July, of whom 135 have arranged to sail on the "Celtic."

The secretary also stated that the memorial window to Sir Benjamin Baker, honorary member American Society of Mechanical Engineers, deceased, was presented by the Earl of Cromer in behalf of the subscribers and accepted by the Dean of Westminster Abbey in December, 1909, and that report including a colored illustration of the window was in preparation by the Institution of Civil Engineers.

PERSONAL

R. D. Brooks, who has been associated with the International Steam Pump Company for many years, severed his connection with this company on April 1 to become general manager of the Bayonne Casting Company, manufacturer and dealer in Monel metal. A. H. Braidwood will succeed Mr. Brooks.

Prof. R. C. Carpenter, of Cornell university, has entered into partnership in New York with E. H. Faile, under the name of Carpenter and Faile, to engage in the mechanical and electrical equipment of buildings, including power plants, heating and ventilation, sanitary installations, elevators and illumination.

Evans, Almirall & Co., announce the engagement of F. H. Stevens, formerly central-station heating engineer for the American District Steam Company, to represent them in the department of Central Station Heating. Mr. Stevens has a thorough knowledge of and has had wide experience in this branch of engineering.

L. J. Wing has recently resigned as president of the L. J. Wing Manufacturing Company and E. D. Fieux has been elected as president of the company, C. E. Cole as vice-president and H. S. Wheller remains as secretary. Mr. Wing still remains as a director and stockholder of the company and will devote considerable time to its interests.

Frank McMurdie, superintendent of the American Blower Company's Detroit plants since about 1894, has resigned, his resignation taking effect March 31. After a short pleasure trip, he will take the general superintendency of the Clarage Foundry and Manufacturing Company, of Kalamazoo. Mr. McMurdie was one of the oldest employees of the American Blower Company, having entered their employ in 1883.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

COMPOUND ROTARY STEAM ENGINE. Oscar O. Nygaard, Newport, R. I. 952,465.

EXPLOSIVE ENGINE. Ralph P. Thompson and Emil Koeb, Springfield, Ohio. 952,483.

INTERNAL COMBUSTION ENGINE. Rakph Lucas, Blackheath, England, assignor to "Valveless" Ltd., London, Eng. 952,706.

STEAM ENGINE. Johann Stumpf, Berlin, Germany. 952,764.

STEAM-TURBINE ENGINE. Ellis F. Edgar, Woodbridge, N. J. 952,791.

ELASTIC-FLUID TURBINE. Raymond N. Ehrhart, Pittsburg, Penn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 952,792.

WATER MOTOR. Charles A. Whelan, Buena Vista, Colo. 952,969.

WINDMILL DRIVE. Robert B. Cummins, Sterling City, Tex. 952,979.

TURBINE. Richard H. Goldsborough, Washington, D C. 953,013.

FURNACES AND BURNERS

FEEDING DEVICE FOR VAPOR BURNERS. Lars O. T. Thompson, Stockholm, Sweden, assignor of one-half to Fritiof Ludvig Ahlsell, Stockholm, Sweden. 952,770.

LIQUID FUEL-BURNING APPARATUS. Frank E. Nelson, Los Angeles, Cal. 952,932.

POWER-PLANT APPLIANCES

STEAM TRAP. William R. Templeton, Boston, Mass., assignor to Templeton Manufacturing Company, Boston, Mass., a Corporation of Maine. 952,482.

THROTTLE VALVE. Edwin de H. Caldwell, St. Charles, Ill., assignor by mesne assignments to the Webb Jay Motor Company, a Corporation of Maine. 952,508.

THROTTLE VALVE. John S. Chambers, Rocky Mount, N. C. 952,510.

SIGHT FEED FOR LUBRICATORS. Frank W. Edwards, Logansport, Ind., assignor to the Chicago Lubricator Co., Chicago, Ill., a Corporation of Illinois. 952,515.

VALVE. Harry M. Hillegass, Philadelphia, Pa. 952,523.

CARBURETER. Josef Schwartz, Bay City, Mich. 952,547.

VAPORIZER. George F. Swain, Chicago, Ill., assignor to Swain Engine Company, Chicago, Ill., a Corporation of Illinois. 952,548.

WATER JACKET FOR ENGINE CYLINDERS. Edward B. Parkhurst, Moline, Ill. 952,576.

VALVE-OILING DEVICE. Walter J. Richards, Milwaukee, Wis., assignor to National Brake and Electric Co., Milwaukee, Wis., a Corporation of Wisconsin. 952,580.

VALVE OR COCK. Patrick J. Connors and George Kitch, Greenville, Penn. 952,605.

SIGHT FEED FOR LUBRICATORS. Frank W. Edwards, Logansport, Ind., assignor to the Chicago Lubricator Co., Chicago, Ill., a Corporation of Illinois. 952,611.

PRESSURE PUMP. Frederick W. Humbarger, Herrington and David J. Foreman, Kansas City, Kan. 952,617.

FEED-WATER PURIFIER. Frank E. Keyes, New York, N. Y. 952,620.

VALVE. John G. Talmage, Cleveland, O. 952,691.

VALVE. Nathan H. Suren, Needham, Mass., assignor to the Gamewell Fire Arms Telegraph Company, New York, N. Y., a Corporation of New York. 952,768.

ROD PACKING. Elmer E. Switzer, Huttig, Ark. 952,769.

STARTING DEVICE FOR EXPLOSION ENGINES. George M. Davis, Manchester, N. H.

AIR COMPRESSOR. Edson F. Gallaudet, Norwich, Conn., assignor to the Platt Iron Works Co., Dayton, Ohio, a Corporation of Ohio. 952,798.

STEAM TRAP. George Keisling, Scranton, and James D. Brown, Dunmore, Pa. 952,814.

LUBRICATING SYSTEM FOR ENGINES. Antoine J. Liberty, Detroit, Mich. 952,824.

VAPOR ROTOR FOR PUMPS. Edward L. Milligan and Frederick D. Cooley, Detroit, Mich. 952,830.

AUTOMATIC SHUT-OFF WATER GLASS. Clement F. Moore, Chicago, Ill. 952,833.

BOILER FEED WATER HEATER AND PURIFIER. Walter J. McKnight, Buffalo, N. Y. 952,930.

WATER GAGE. Julius Torok, Renovo, Penn. 952,999.

TURBINE BLADE AND VANE. Henry S. Lord, Morristown, N. J., and Joseph Panter, Stretford, Manchester, England, assignors to the Westinghouse Machine Company, a Corporation of Pennsylvania. 953,016.

ELECTRICAL APPARATUS

OSCILLATING ELECTRIC FAN. Charles R. Meston, and Herbert I. Finch, St. Louis, Mo., assignors to Emerson Electric Manufacturing Company, St. Louis, Mo., a Corporation of Missouri. 952,458.

ALTERNATING-CURRENT MOTOR. Waldo A. Layman, Webster Groves, Mo. 952,532.

ALTERNATING-CURRENT MOTOR. Valere A. Fynn, London, England, assignor to Wagner Electric Manufacturing Company, St. Louis, Mo., a Corporation of Missouri. 952,566.

INDUCTIVE MOTOR-CONTROLLING APPARATUS. August Sundh, Yonkers, N. Y., assignor to Otis Elevator Company, Jersey City, N. J., a Corporation of New Jersey. 952,650.

SPARK COIL. Chester H. Thordarson, Chicago, Ill. 952,692.

ELECTRIC IGNITER FOR EXPLOSIVE SHELLS. Paul Schwenke, Zerbst, Germany. 952,760.

ELECTRIC HEATER AND COOKING APPARATUS. Frank C. Perkins, Buffalo, N. Y., assignor of one-half to Ferdinand E. Finsterbach, Buffalo, N. Y.

ELECTRIC TIME-SWITCH MECHANISM. A. B. Shaw, West Medford, Mass. 952,953.

ELECTRICAL PLUG RECEPTACLE. Geo. B. Thomas, Bridgeport, Conn., assignor to the Bryant Electric Company, Bridgeport, Conn., a Corporation of Connecticut. 952,961.

ELECTRIC VACUUM MILKING MACHINE. George B. Cramp, Duquesne, Pa.

MISCELLANEOUS TOOLS

PIPE-THREADING TOOL. John B. Phillips, Warren, Ohio, assignor to the Borden Company, Warren, Ohio, a Corporation of Ohio. 952,629.

State Conventions

POWER has written to the secretaries of the several State associations of the National Association of Stationary Enneers requesting particulars regarding their conventions for 1910. Up to the time of going to press the associations of Indiana, Texas and West Virginia have not replied. Following are the dates and places of the annual meetings of the State associations from whom we have heard:

Iowa, at Waterloo, May 5, 6 and 7.

Illinois, at Moline, May 21.

California, at Los Angeles, May 23 to 28.

Pennsylvania, at Scranton, June 3 and 4.

New Jersey, at Jersey City, June 4.

Colorado, at Denver, June 10.

Kentucky, at Hopkinsville, June 10 and 11.

New York, at Buffalo, June 10 and 11.

Ohio, at Hamilton, June 16, 17 and 18.

Wisconsin, at Oshkosh, June 17, 18 and 19.

Connecticut, at New Haven, June 24 and 25.

Massachusetts, at Lowell, July 7, 8 and 9.

Michigan, at Kalamazoo, July 21, 22 and 23.

Canadian Association of Stationary Engineers at Berlin, Ont., July 26, 27 and 28.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., William G. Snow; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June 6-10, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio. Next meeting, Cincinnati, May 19 and 20, 1910.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Niagara Falls, Canada, May 24-27, 1910.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

MOMENTS WITH THE Advertising Editor

A Department for Subscribers Conducted by the Business End of Power and the Engineer

Once upon a time we wrote a little screed on "Advertising" and printed it among the advertising pages.

It began something like this:

"Back of every advertisement in this paper is a story—the gripping story of an idea that took shape in the mind of some man and finally evolved into the finished product you see advertised."

Of course there was more than that to it, but in the opening paragraph we tried to express the *romance* of manufacturing.

The average hard headed business man and the equally hard headed buyer will scoff at the thought of romance connected with the making of machinery. Those same men will shed tears over the woes of the lady in black at the drama and madly applaud when the hero yanks her from in front of the on-rushing papier-mâché locomotive.

All of us are so prone to overlook the real and thrill at the make-believe.

The histories of great inventions, dramatized, would make great plays.

Bell's struggle and final success with the telephone is a glittering example.

The lesser inventions have their history of romance but the limelight has been focused elsewhere and they have passed unnoticed.

We might take any single machine or device in the advertising pages of this paper and just the bare history of it, written, would make good reading.

We remember that James L. Robertson, Sr., wrote the history of Eureka Packing and made of it a series of the most interesting sort of advertisements.

We believe that others might profit by this example and that readers will be entertained and the advertisers profited.

But that, as Kipling says, is another story.

This is the point we want to draw from the lesson of the older inventions:

Their great struggle was to command the services of capital and the attention of the public.

And on these rocks many inventors of highly commendable things wrecked their hopes.

And many commendable devices were lost to a public which might have benefited by them.

But the situation has changed and the credit for the change belongs to *advertising*.

Just that, advertising. Bless you, advertising is nearly as old as mankind; we're talking about the modern, scientific application of this economic power.

In the old days, capital fought shy of new inventions because capital feared the uncertainties and slow growth of public confidence.

Advertising meant nothing to capital because advertising in those days was not understood nor appreciated.

Today, capital is chiefly concerned with the merit of the invention and the possible demand for it.

It knows that by the proper application of the great creative power, advertising, it can produce business almost instantly; certainly instantaneously compared with the stage-coach method of 25 years ago.

So capital creeps out from under the bed and works up its circulation by some healthy exercise.

Meritorious inventions are marketed; the world is told of them in short order and the world, buying, profits because the new device saves time or money or labor.

Therefore, advertising, like any good contract, works both ways, benefits both parties.

Advertising from your point of view is *education*.

You are no longer kept in ignorance of new and improved devices for accomplishing better results in your work—every week they are spread before you in this paper.

Whether they appeal to your judgment or meet your requirements are questions for you to decide.

But you can't learn of them through a lowered curtain.

And taking an occasional peek behind the scenes won't give you more than a smattering of the exhibition.

Make a point of reading the advertisements *weekly*, not *weakly*.

Mainly because it will *pay* you.